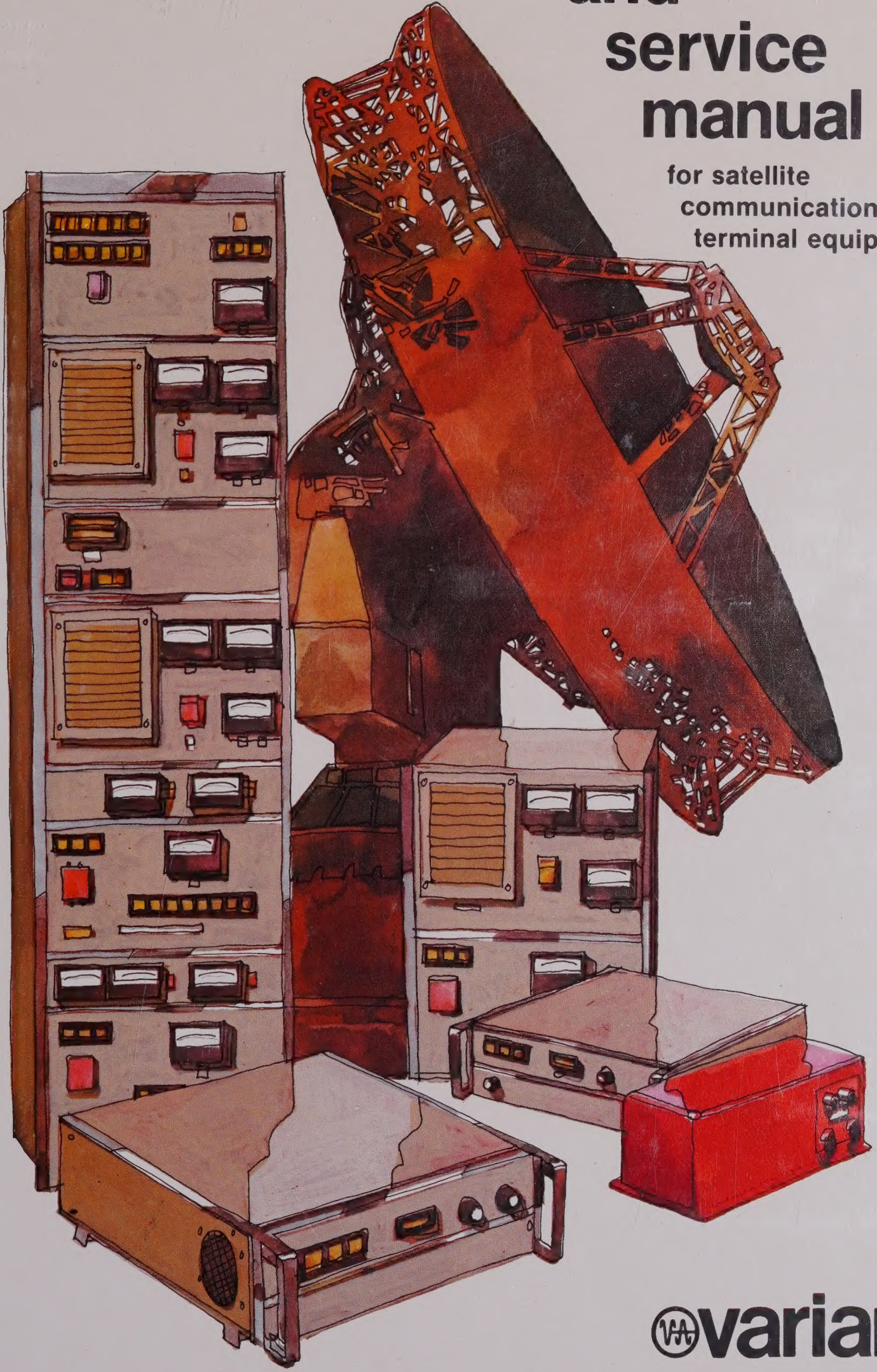
operating and service manual

for satellite
communications
terminal equipment



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5902-20-01

OPERATING AND SERVICE MANUAL
FOR
"K" SERIES
CW MEDIUM POWER AMPLIFIERS

JUNE 1981

VARIAN ASSOCIATES

MICROWAVE COMPONENTS AND SUBSYSTEMS DIVISION

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SANTA CLARA, CALIFORNIA 95050-1288

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SAFETY SUMMARY

THIS EQUIPMENT HAS BEEN DESIGNED TO MINIMIZE EXPOSURE OF PERSONNEL TO SAFETY HAZARDS. THE NATURE OF THE EQUIPMENT IS SUCH THAT THERE ARE CERTAIN INHERENT HAZARDS THAT REQUIRE THAT THE OPERATOR OR TECHNICIAN WORKING WITH THIS EQUIPMENT HAVE CERTAIN SPECIFIC TRAINING AND KNOWLEDGE. THE RF AMPLIFIER TUBES USED IN THE EQUIPMENT OPERATE WITH HIGH VOLTAGE POWER SUPPLIES AND DELIVER HIGH LEVELS OF MICROWAVE ENERGY. OPERATORS OR TECHNICIANS THAT WORK WITH THIS EQUIPMENT MUST BE TRAINED IN THE USE OF SUCH EQUIPMENT AND FAMILIAR WITH THIS PARTICULAR UNIT. GUIDELINES FOR DEALING WITH SAFETY HAZARDS ARE INCLUDED IN THE SUPPLEMENTARY DATA SECTION OF THIS MANUAL. YOU SHOULD BECOME FAMILIAR WITH THESE GUIDELINES PRIOR TO OPERATING OR SERVICING THE EQUIPMENT.

PLEASE READ AND OBSERVE THE FOLLOWING CAUTIONS AND WARNINGS THAT ARE CONTAINED IN THE BODY OF THIS MANUAL.

CAUTION/WARNING	TEXT PAGE
WARNING	
LETHAL VOLTAGES UP TO 5 KV ARE PRESENT IN THE POWER AMPLIFIER WHEN IT IS OPERATING. USE EXTREME CAUTION WHEN WORKING INSIDE THE UNIT. AS AN ADDED PRECAUTION, IT IS RECOMMENDED THAT ANOTHER PERSON BE PRESENT TO GIVE AID IN CASE OF ACCIDENT.	2-3 5-10
CAUTION	
PRIOR TO PROCEEDING WITH INITIAL TURN-ON, ALL PROCEDURES DEFINED IN SECTION 4 SHOULD BE COMPLETE AND VERIFIED.	2-6
CAUTION	
DO NOT EXCEED THE LIMITS SPECIFIED IN THE TWTA DATA SHEETS.	2-8

CAUTION/WARNING	TEXT PAGE
CAUTION OPERATING THE TWTA WITH UNTERMINATED OR EXCESSIVE LOAD VSWR COULD CAUSE DESTRUCTION OF THE TWT AND WILL VOID THE WARRANTY. THE MAXIMUM LOAD VSWR SHOULD NOT EXCEED 1.5:1.	4-4
WARNING LETHAL VOLTAGES UP TO 5 KV ARE PRESENT WHEN POWER IS APPLIED TO THE SYSTEM. BE EXTREMELY CAREFUL WHEN WORKING INSIDE THE UNIT. USE ONLY ONE HAND TO MAKE MEASUREMENTS OR ADJUSTMENTS. IF POSSIBLE TURN POWER OFF BEFORE MAKING ADJUSTMENTS. DO NOT ATTEMPT TO REPAIR OR TROUBLESHOOT THIS UNIT UNLESS YOU HAVE HAD EXPERIENCE IN SERVICING BOTH MICROWAVE AND HIGH VOLTAGE SYSTEMS AND HAVE READ THE GUIDELINES IN THE SUPPLEMENTARY DATA SECTION OF THIS MANUAL PERTAINING TO HIGH VOLTAGE AND MICROWAVE RADIATION.	5-1
CAUTION BE SURE TO TERMINATE THE RF INPUT BEFORE APPLYING PRIME POWER.	5-2
WARNING TURN ALL POWER OFF BEFORE ATTEMPTING ANY CLEANING OPERATION. WHEN USING SOLVENTS BE SURE TO PROVIDE ADEQUATE VENTILATION AND AVOID BREATHING THE FUMES. WHEN CLEANING WITH AIR, WEAR SAFETY GOGGLES AND USE CLEAN, DRY, COMPRESSED AIR, NOT EXCEEDING 25 PSI.	5-4
CAUTION THIS AMPLIFIER USES AN OFF-LINE REGULATOR TO DEVELOP THE VOLTAGES USED TO OPERATE THE TWT. EXTRA PRECAUTIONS ARE NECESSARY BEFORE THE AMPLIFIER IS SERVICED. IT IS SUGGESTED THAT AN ISOLATION TRANSFORMER BE USED TO PROVIDE AC POWER TO THE AMPLIFIER BEFORE SERVICING THE UNIT.	5-11

CAUTION/WARNING	TEXT PAGE
WARNING	
GRID ADJUSTMENTS MUST BE PERFORMED WITH H.V. OFF. IF H.V.IS ON, THIS WOULD FORCE THE DVM AND THE ADJUSTMENT POTENTIOMETERS TO BE AT CATHODE (H.V.) POTENTIAL. THE FOLLOWING ADJUSTMENTS ARE MADE WITHOUT TURNING ON THE HIGH VOLTAGE.	5-17
CAUTION	
THIS AMPLIFIER USES AN OFF-LINE REGULATOR TO DEVELOP THE VOLTAGES USED TO OPERATE THE TWT. EXTRA PRECAUTIONS ARE NECESSARY BEFORE THE AMPLIFIER IS SERVICED. IT IS NECESSARY THAT AN ISOLATION TRANSFORMER BE USED TO PROVIDE AC POWER TO THE AMPLIFIER BEFORE SERVICING THE UNIT. IF AN ISOLATION TRANSFORMER IS NOT USED, ALL VOLTAGE AND SCOPE MEASUREMENTS MADE ON THE POWER PROCESSOR PCB (A2) WILL FORCE THE TEST EQUIPMENT TO FLOAT AT THE LINE POTENTIAL. IF THE TEST EQUIPMENT IS GROUNDED, THEN DAMAGE WILL BE INDUCED IN THE TWTA. IF THE TEST EQUIPMENT IS NOT GROUNDED, THE TEST EQUIPMENT WILL BE HAZARDOUS BECAUSE IT WILL BE AT LINE POTENTIAL.	5-23
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THE RETURN FOR THE 1A2U10, 1A2U11, and 1A2U12 SUPPLIES IS ABOVE CHASSIS GROUND.	5-24

WARNING

Lethal voltages are present when power is applied to the system. Be extremely careful when working inside the unit. Use only one hand to make any measurements or adjustments. If possible, turn power off before making adjustments. Do not attempt to repair or troubleshoot this unit unless you are thoroughly familiar with its operation and are experienced in servicing high voltage equipment.

Exposure to microwave radiation can produce unwanted biological effects. Protect yourself and those around you from unwanted RF exposure. Always terminate the amplifier input and output with an RF dummy load (or a short) before you turn the high voltage on. This will reduce the chances of oscillation due to internal amplifier noise.

SECTION 1

INTRODUCTION

1.1 GENERAL

The Varian "K" series Medium Power Amplifiers (Figure 1-1) are completely self-contained units that provide all necessary power supplies, forced air cooling, RF components, control and indicators required to support a variety of TWTs with power capabilities of 10 to 20 watts CW. Table 1-1 lists the available tube types. The 3-1/2" high units are designed for bench top operation or slide mounting in a standard 19-inch rack cabinet. Standard prime power for the unit is 115 VAC 50-60 Hz.

1.2 TWTs AND OPTIONS AVAILABLE

A number of TWTs and options can be specified for the "K Series" amplifiers.

1.2.1 TWTs Available

The basic model number of an individual amplifier is directly related to the TWT selected for a particular application. Table 1-1 presents the basic "K-Series" model numbers, the specific TWT for that model number, and the gain, frequency band and output power level of that TWT.

1.2.2 Standard Options Available

Standard options available are summarized in Table 1-2.

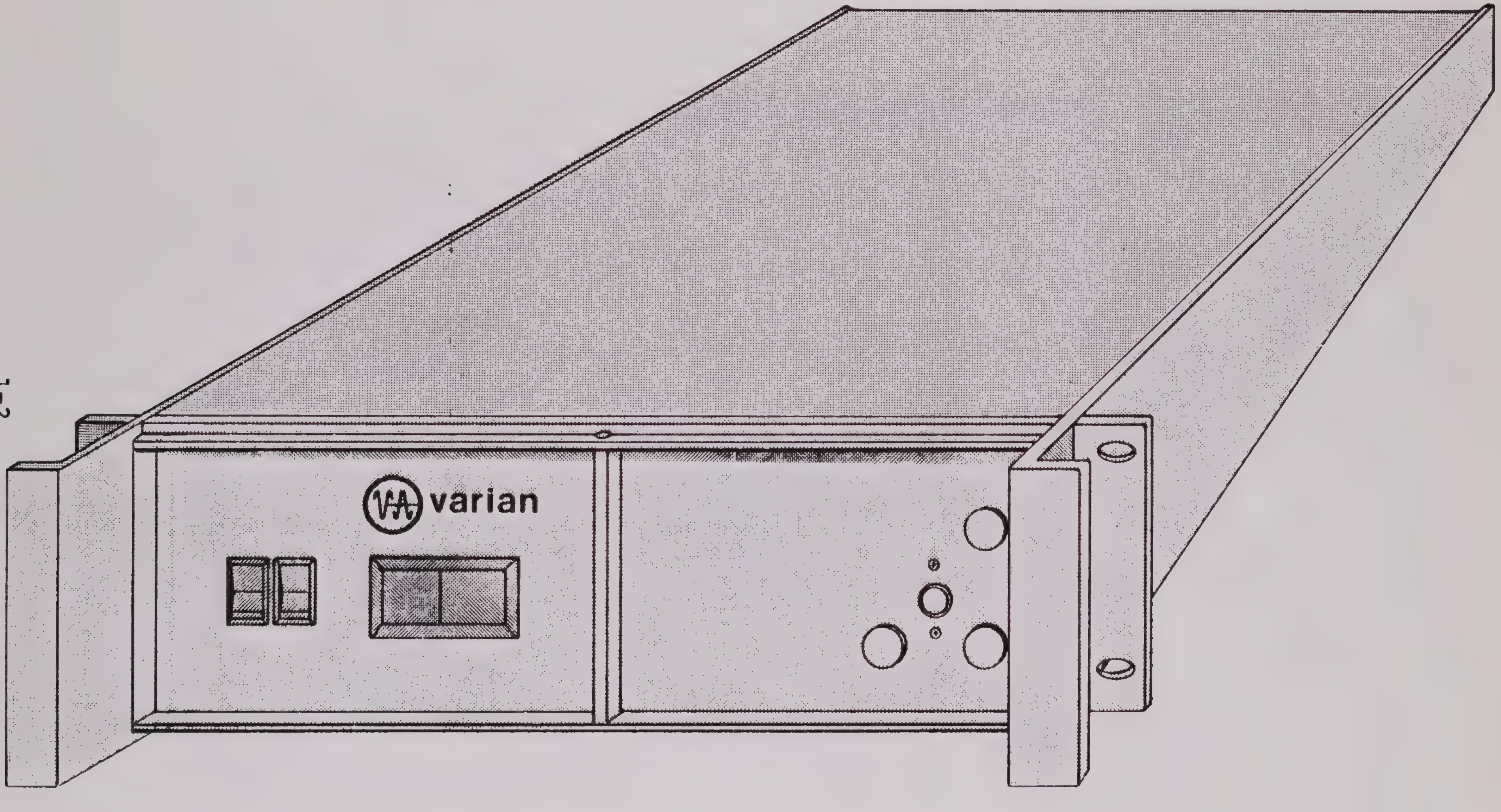


FIGURE 1-1 POWER AMPLIFIER

TABLE 1-1

LIST OF AVAILABLE TUBE TYPES

AND THE ASSOCIATED TWTA MODEL NO.

TWTA MODEL NUMBER	TWT NUMBER	TWT OUTPUT POWER WATTS	FREQUENCY GHz	NOMINAL GAIN (dB)
VZS-6950K1	VTS-6055A1	10	2.0 - 4.0	30
VZH-6970K1	VTH-6079H1	10	4.0 - 10.0	35
VZX-6980K2	VTX-6089H3	10	8.0 - 12.4	40
VZL-6941K1	VTL-6140B1	20	1.0 - 2.0	35
VZS-6951K1	VTS-6150B1	20	2.0 - 4.0	35
VZS-6951K2	VTS-6150J1	20	2.0 - 4.0	54
VZC-6961K1	VTC-6166B1	20	4.0 - 8.0	35
VZC-6961K2	VTC-6166J1	20	4.0 - 8.0	50
VZX-6981K1	VTX-6186B1	20	8.0 - 12.4	40
VZU-6991K1	VTU-6196B2	20	12.0- 18.0	40
VZM-6991K3	VTM-6196B1	20	8.0 - 18.0	40
VZU-6990K1	VTM-6096R1	10	8.0 - 18.0	37
VZU-6998K1 *	VTU-6090A1	2	12.4- 18.0	30

* See Special Features for difference between 10-20W TWTA and low power TWTA.

1.2.3 Non-Standard Options (Special Features)

Non-standard options, designated as Special Features, are also available to meet specific application requirements. In the past, Special Features requested have included:

a. Optomized power and gain over non-standard frequency ranges.

b. More stringent environmental performance

c. Special finishes

1.3 MODEL NUMBER INTERPRETATION

Each "K Series" configuration is designated by a specific model number. When the configuration is a basic unit plus four or less standard options, the model number completely describes the unit (see Table 1-2). Units that are special because they incorporate non-standard options (Special Features) are described in engineering drawings that correlate with the Model Number. When Special Features are included they are described in detail in the Special Features Section of this manual. Engineering drawings that defines a specific Model Number incorporating Special Features are included in the Special Features Section of this manual.

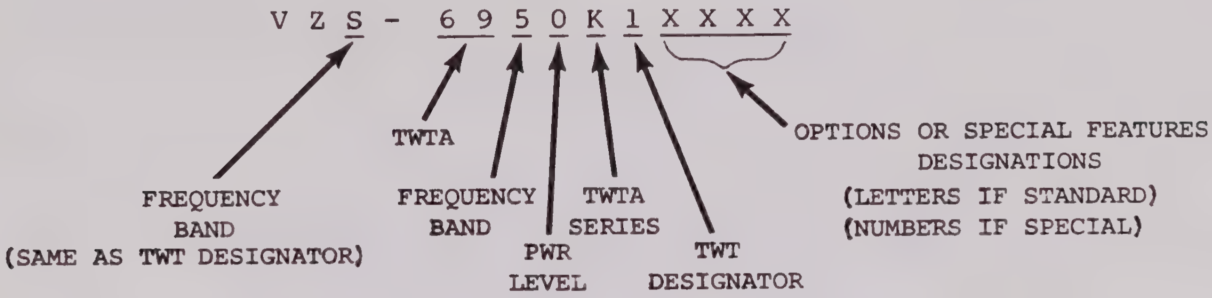
1.4 SPECIFICATIONS

The unit is designed to meet the specifications defined in Tables 1-3 and 1-4.

TABLE 1-2

"K SERIES" MODEL AND OPTION DESIGNATIONS

Standard form of "K Series" Model Numbers. Example:


V Z S - 6 9 5 0 K 1 X X X X
TWTA
FREQUENCY BAND (SAME AS TWT DESIGNATOR)
FREQUENCY BAND
PWR LEVEL
TWTA SERIES
TWT DESIGNATOR
OPTIONS OR SPECIAL FEATURES DESIGNATIONS
(LETTERS IF STANDARD)
(NUMBERS IF SPECIAL)

Basic unit without options would be:

Example: VZS-6950K1

Standard Options Available:

A. Input Isolator
B. Input Attenuator
C. Harmonic Filter
D. Output Isolator
E. Output Sample Port
F. Chassis Slides
G. Remote Interface
H. Elapsed Time Meter
J. Rear RF Connectors
K. 115/230 VAC Prime Power

Model Number with four or less standard options. Example:

VZS-6950K1ADFK (Includes Input Isolator, Output Isolator, Chassis Slides and 115/230 VAC power).

Model number for special features and/or more than four options.

Example: **VZS-6950 1432**

TABLE 1-3

ELECTRICAL SPECIFICATIONS OF STANDARD "K-SERIES" CW POWER AMPLIFIERS

PARAMETER	VALUE
Power Levels	10 to 20 watts CW standard
Frequencies	1 - 18 GHz
Gain	30 - 60 dB
Input/Output Impedance	50 ohms nominal TWT impedance or waveguide
Noise Figure	30 dB max. of all 1, 2 and most 10 watt CW TWTAs; 35 dB max. for 20 watt CW and above TWTAs.
Power Output Stability	Typically ±0.25 dB/24 hours at constant drive and constant temperature.
Spurious, AM and PM Noise Levels	Total spurious output typically -50 dBc, excluding harmonics and residual modulation.
Prime Power	115 volts ± 10%, 50/60 Hz, single phase. Optional 115/230 VAC operation.

TABLE 1-4

MECHANICAL/ENVIRONMENTAL SPECIFICATIONS "K-SERIES" CW POWER AMPLIFIERS

PARAMETER	VALUE
Size (H x D x W)	Height 3-1/2 in. (8.9 cm) x Length 21 in. (53.3 cm) x Width 19 in. (48 cm).
Weight	35 lbs. max (32.1 kg)
Cooling	Integral forced air, rear panel intake and exhaust
Temperature Range	0 to +50° standard operation. All metal ceramic tubes rated for high reliability in military environments, typically -54°C to +110°C.

1.5 GENERAL DESCRIPTION

The amplifiers are modular and designed for simple and reliable operation. They are self-protecting against damage from most internal and external fault conditions. The full specified frequency band is covered without need for tuning or operator adjustment. Once placed into operation, the amplifiers will automatically recycle after prime power interruption in as short a time as possible consistent with TWT warm-up requirements and return to the mode selected before the power interruption.

The power amplifier is contained in a single 48.26 cm (19-inch) wide drawer assembly designed for slide mounting in a standard 48.26 cm rack cabinet. The amplifier is 8.89 cm (3-1/2 inches) high by 50.8 cm (20 inches) deep. Functionally, the TWTA can be divided into the Power Supply section and the RF section. Physically, the unit consists of the following:

Control/Indicator Assembly
Main Chassis Assembly
Power Processor PCB Assembly
High Voltage Assembly
Optional PCB Assemblies
RF Components

1.5.1 Control/Indicator Assembly

The Control/Indicator Section consists of switches, indicators and a logic card that forms the left hand Front Panel Assembly. The switches control Prime Power (ON/OFF), High Voltage (ON/OFF) and fault indicator reset. Individual LED indicators display PRIME POWER ON, STANDBY, OPERATE, SUMMARY FAULT, and HELIX FAULT. HELIX CURRENT is displayed with an LED linear array. (See Section 4.0 for specifics on the controls and indicators). All logic functions required for the Power Amplifier are incorporated into the Logic PCB which is mounted on the left hand Front Panel.

1.5.2 Main Chassis Assembly

All of the major assemblies are mounted on the Main Chassis Assembly. The rear panel of the Main Chassis incorporates the programmable power plug, interface connections, cooling fan and optional rear mounted RF connectors. The bottom of the Main Chassis serves as a base plate.

A portion of the Prime Power Interface circuits, the distributor and optional auto transformer and some large capacitors are included as part of the Main Chassis Assembly. Approximately one-half of the interior of the Main Chassis is used to mount the TWT and other RF components.

1.5.2.1 Prime Power Interface Circuits. Standard prime power is 115 VAC 50-60 Hz. The standard prime power interface circuits include an RFI line filter and a bias transformer for the low voltage supplies. Non-standard prime power is accommodated by alternate components added to the prime power interface circuits.

1.5.3 Power Processor PCB.

The Power Processor incorporates a switching regulator and power converter to drive the High Voltage Assembly and a set of rectifiers, filters and regulators that supply the necessary regulated low voltages for the fan, logic and indicator circuits. This assembly also includes circuits to limit in-rush current during TWTA turn-on, protection circuits and foldback current limiting.

1.5.4 High Voltage Assembly.

The High Voltage Assembly provides the filament, grid anode, helix and collector voltages required to operate the family of TWTs that can be used in the "K-Series" CW power amplifiers.

1.5.5 RF Components

The RF Section includes the RF input and output connection (which are normally mounted on the right Front Panel), the TWT, and all associated optional RF components such as attenuators, elapsed time meter, directional coupler, isolators, filter, etc., that are selected for a particular model.

1.5.6 Other Components

Additional assemblies such as the Grid/Anode PCB, Remote Control Assembly and 115/230V auto-transformer are also included in certain models to support specific options.

SECTION 2

OPERATION

2.1 GENERAL

This section describes normal operation of the TWTA. The operating modes, the controls, indicators and meters, and the turn-on turn-off procedures are discussed. All controls are located on the front or rear panel of the TWTA. Status and fault indicators display the status of the unit at all times. Helix current is displayed on the Front Panel.

Once the unit has been placed in operation, it is suggested that a log be kept which records current readings, approximate running time, approximate RF power output, and all maintenance activity.

2.2 OPERATING MODES

A Front Panel Indicator (Power ON) indicates when the TWTA is turned on. There are four operating modes for the TWT amplifier. The modes are: Filament Time Delay, Standby, Operate and Fault.

2.2.1 Filament Time Delay

In this mode, which occurs immediately after prime power is turned on (Power ON), the power supply provides power to the TWT Filament (Heater). Helix and collector voltages are inhibited for approximately 3 minutes after initial TWTA turn-on. After the TWT heater has reached its operating temperature, the inhibit circuits de-energize and high voltage may be applied to the TWT.

The Filament Time Delay circuitry provides for proportional time delay in the event that a prime power failure occurs. If prime power is interrupted during normal operation, the Filament Time Delay circuits will automatically recycle. The circuits are designed so that a full three minute delay is not required if the outage period is short (up to 89 seconds) and the recycle period is proportional to the outage period. Longer outage periods (more than 90 seconds) result in a full three minute delay.

If the TWTA is in the OPERATE mode and a power outage occurs, the TWTA will automatically recycle back to the OPERATE mode when the delay period is over.

If the TWTA is in the STANDBY mode it will automatically recycle to the STANDBY mode after a power outage period.

NOTE

> Use of the Power ON switch to turn the TWTA on and off results in the same performance as that associated with prime power outages external to the TWTA.

2.2.2 Standby

This mode sequentially follows the Filament Time Delay and is indicated by the STANDBY LED being lit. In this mode, filament voltage is applied to the TWT and high voltage is off. STANDBY is defined as no filament time delay, high voltage OFF and no faults.

2.2.3 Operate

The OPERATE indicator lights whenever the HV ON control switch has been pressed requesting the HV ON, and there are no faults or Filament Time Delay. In this mode Collector and Helix voltages are applied to the TWT.

2.2.4 Fault

The Fault mode is indicated by the SUM FAULT indicator (and possibly the Helix Fault indicator) being lit. The SUM FAULT indicator is a summary alarm. The following faults cause the fault indicator to light: high helix current, TWT overtemperature, internal interlock open and certain over/under voltage or current conditions. The SUM FAULT indicator also indicates a lockout condition. After a fault indication,the HV ON switch must be turned OFF to reset the fault and then turned ON again to restore an OPERATE condition and clear the fault indicators.

****

WARNING

****

LETHAL VOLTAGES UP TO 5 KV ARE PRESENT IN THE POWER AMPLIFIER WHEN IT IS OPERATING. USE EXTREME CAUTION WHEN WORKING INSIDE THE UNIT. AS AN ADDED PRECAUTION, IT IS RECOMMENDED THAT ANOTHER PERSON BE PRESENT TO GIVE AID IN CASE OF ACCIDENT.

****

2.3 METERS, CONTROLS AND INDICATORS

Figures 2-1 and 2-2 are annotated photographs of the Front and Rear Panels of the TWTA.

2.4 INITIAL TURN-ON

The first time the TWTA is turned on after installation at the user site certain precautions must be taken to protect the power amplifier against damage from unknown conditions. Once proper overall operation is verified in the final installation, turn-on and turn-off can be accomplished as described in subsequent sections.

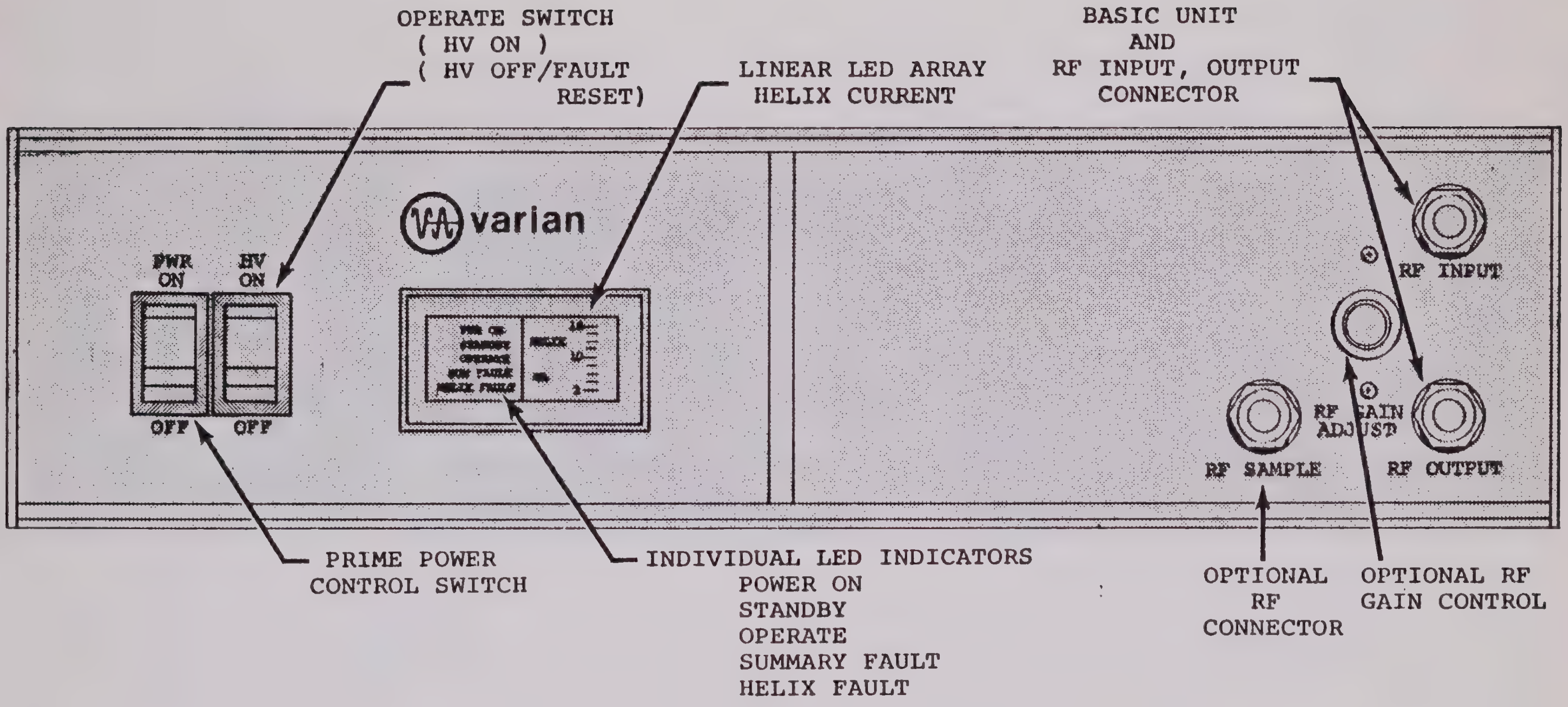

OPERATE SWITCH
(HV ON)
(HV OFF/FAULT RESET)
LINEAR LED ARRAY HELIX CURRENT
BASIC UNIT AND RF INPUT, OUTPUT CONNECTOR
varian
PWR ON
OFF
HV ON
OFF
HELIX
RF INPUT
RF GAIN ADJUST
RF OUTPUT
RF SAMPLE
PRIME POWER CONTROL SWITCH
INDIVIDUAL LED INDICATORS
POWER ON
STANDBY
OPERATE
SUMMARY FAULT
HELIX FAULT
OPTIONAL RF CONNECTOR
OPTIONAL RF GAIN CONTROL

FIGURE 2-1 TWTA FRONT PANEL

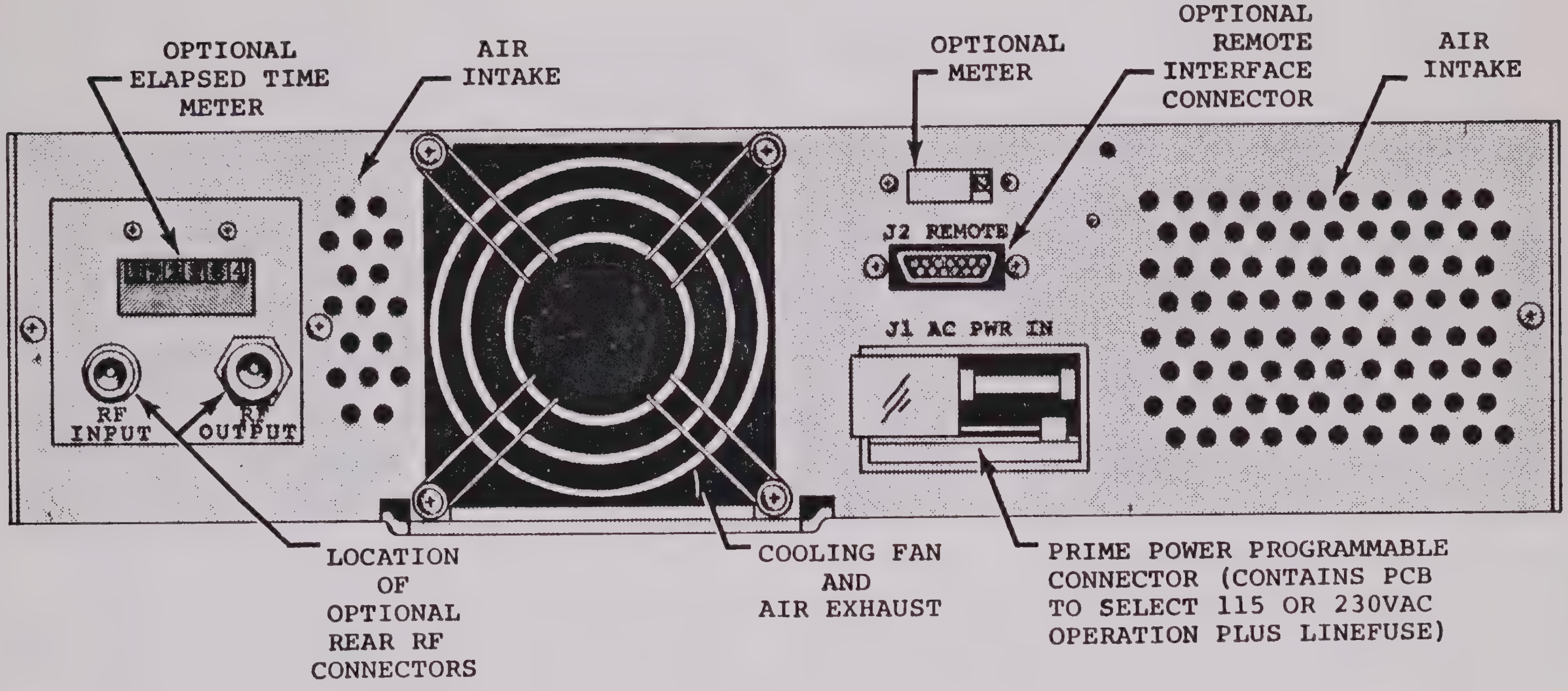

OPTIONAL ELAPSED TIME METER
AIR INTAKE
OPTIONAL METER
OPTIONAL REMOTE INTERFACE CONNECTOR
AIR INTAKE
J2 REMOTE
J1 AC PWR IN
RF INPUT
RF OUTPUT
LOCATION OF OPTIONAL REAR RF CONNECTORS
COOLING FAN AND AIR EXHAUST
PRIME POWER PROGRAMMABLE CONNECTOR (CONTAINS PCB TO SELECT 115 OR 230VAC OPERATION PLUS LINEFUSE)

FIGURE 2-2 TWTA REAR PANEL

CAUTION

Prior to proceeding with initial turn-on, all procedures defined in Section 4 should be complete and verified

2.4.1 Pre-Power Check

Prior to applying prime power to the system, verify that the following conditions are met:

a. Available prime power voltage is within the ratings of the amplifier and that the rear panel connector is properly programmed.

b. The output is terminated in a load capable of dissipating at least twice the rated output power at the intended operating frequency.

c. The load VSWR is less than 1.5:1.

d. An RF drive source is set to the correct frequency and preset for minimum output. (Do not operate the TWTA without either a drive source or an input termination.

e. The rear air exhaust and intake ports and the side air intakes of the TWT Assembly are not blocked.

Failure to observe any of the above conditions can cause catastrophic damage to the unit and will void the warranty.

NOTE

The unit was adjusted and tested at the factory prior to shipment and no further adjustments should be required.

2.4.2 Turn-On Sequence

a. If an RF drive source is connected to the TWTA, rotate the GAIN control of this source to the minimum output power level setting. Set the HV control switch to OFF.

b. Turn on the Power ON Switch. Verify that only the PWR ON indicator illuminates. No readings should be obtained on the HELIX CURRENT meter at this time.

c. Approximately 3 minutes after power is applied the STANDBY indicator should illuminate.

d. Set the HV CONTROL switch to HV ON. Verify that the STANDBY indicator extinguishes and the OPERATE indicator illuminates. Verify that a helix current reading is obtained on the display. Verify that this reading is consistent with the tube data sheet supplied with the unit.

e. Slowly increase the RF drive and verify on the external power meter that RF is being amplified.

NOTE

If the optional Gain Control is included in your TWTA and no reading is obtained on the external power meter, rotate the GAIN control clockwise until the desired output is obtained.

CAUTION

Do not exceed the limits specified in the TWTA Data Sheets.

f. Set the HV CONTROL SWITCH to OFF. Verify that the OPERATE indicator extinguishes, and the STANDBY indicator illuminates.

The power amplifier system is now in normal operation and may be turned on and off as described below.

2.5 NORMAL TURN-ON

Once the steps defined in Section 2.4 have been completed, normal turn-on can be accomplished very simply, unless there is reason to suspect that a significant change in operating conditions has occurred during the off time. The following steps assume that the normal turn-off procedure has been followed:

a. Turn the power switch to the ON position and verify that the PWR ON indicator is illuminated.

b. When the filament time delay is complete (after 3 minutes), verify that the STANDBY indicator illuminates. Operate the HV CONTROL switch and verify normal current meter reading and output RF level.

c. If automatic turn-on is desired, the HV ON switch may be left in the HV ON position. In this mode, when the filament time delay is complete, the unit will automatically return to full operation.

2.6 TURN-OFF

If the Power Amplifier is to be turned off for a short time, (e.g., less than 2 hours) it should be placed in STANDBY by setting the HV Control Switch to OFF. This permits the fan to run and minimizes thermal and electrical shock to the heater. If the off-time is to be extended, the unit should be turned off completely to save heater life and prime power.

a. Set the HV Control switch to OFF.

b. Let the system run in the STANDBY mode for 5 minutes in order to cool the TWT and all other components.

c. Turn the Power Switch to the OFF position to remove prime power from the unit.

SECTION 3

UNPACKING AND INSTALLATION

3.1 UNPACKING AND INSPECTION

3.1.1 Pre-Inspection

Prior to unpacking, inspect the exterior of the packing container for evidence of damage in shipment. If damage seems evident, immediately contact the carrier that delivered the unit and submit a damage report. Failure to do so could invalidate future claims.

3.1.2 Unpacking

Carefully unpack and remove all items. Save all packing material until all inspections are complete. It is recommended that all packing material be saved for potential future use.

3.1.3 Check Packing Slips

Verify that all items listed on the packing slips have been received.

3.1.4 Post Unpacking Inspection

Inspect all items for evidence of damage in shipment. If damage seems evident, immediately contact the carrier that delivered the equipment and file a claim. Failure to do so could invalidate future claims.

Check the unit thoroughly for damaged or loose parts. To remove the top cover of the RF unit, unscrew the screws at the rear of the cover and lift the cover off. After visual inspection is complete, reinstall the cover and tighten the screws.

3.1.5 Pre-Installation Electrical Inspection

A preliminary electrical inspection can be performed at this time. However, due to the complexity of interconnection, it is advised that electrical inspection be performed after installation of the equipment in its final rack or bench assembly. If it is desired to conduct an electrical inspection prior to installation in the final assembly, refer to Section 4 for procedures. The following basic steps must be completed.

a. Verify a proper termination on the input and output of the TWTA.

b. Verify proper AC prime power connections to the TWTA.

c. Follow the initial turn-on procedures as detailed in Section 4.0.

3.2 MECHANICAL INSTALLATION

The following procedures should be followed for installation of the TWTA into the final rack assembly.

3.2.1 Rack Installation (Optional)

The TWTA may be mounted) in a standard 48 cm (19 in) wide RETMA rack cabinet using optional chassis slides. The following procedures should be followed:

a. Locate the desired front panel arrangement and exact panel locations for the TWTA on the rack cabinet.

b. Mount the mating slides (supplied when the option is selected) to the rack cabinet. Refer to the outline drawings of the TWTA included in Section 6 of this manual for exact dimensioning of the rack slide center lines with relation to the unit front panel.

c. Remove feet and bail assembly, install the TWTA.

d. Once the unit is installed on the slides and fastened to the cabinet, the balance of the installation procedures can be completed.

3.2.2 RF Connections

This applies to most models. Carefully align interconnecting cables so as to minimize sidewise stress on the fittings. Screw on connections taking care not to overtighten. (This could damage connector intefaces or threads.)

CAUTION

Operating the TWTA with unterminated or excessive load VSWR could cause destruction of the TWT and will void the warranty. The maximum load VSWR should not exceed 1.5:1.

3.2.3 Cooling

The TWTA is forced air cooled. The exhaust air from the TWTA may be at a relatively high temperature and heat dissipation may be as high as 400W. In order to prevent heat buildup, it is advisable that the exhaust air be directed away from the air intake areas located on the rear and side of TWTA. A minimum of eight inches of free space should be left at the rear and four inches from sides of the TWTA. If exhaust ducting is to be provided, the external ducting must have a cross sectional area at least equal to that of the exhaust opening. Exhaust duct bends and transitions must be smooth and bend radii should be as large as possible. In most cabinet installation it is suggested that an exhaust fan be located at the top of the equipment rack.

3.3. ELECTRICAL INTERCONNECTION

Electrical interconnections to the system consist of prime power, ground connections and external connections.

3.3.1 AC Prime Power

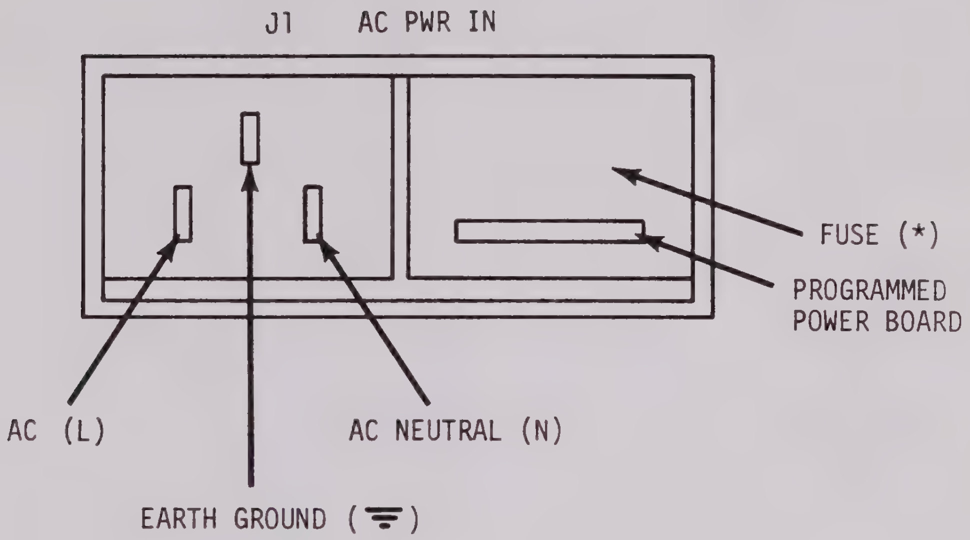
Prime power requirement for the subsystem is nominal 115/230 VAC, 50-60 Hz. Prime power must be single phase, 3 wire, with the third wire earth ground. Wire used for applying prime power to the system should be sized for the appropriate current, as determined by the prime power voltage, for a nominal 500 VA power consumption. Power is applied to connector J1 located on the rear panel of the TWTA. Prime power is applied to terminals L and N of J1 and the earth ground wire is supplied to GRD. If the PCB is installed incorrectly, the results are fairly easy to detect, e.g., if set for 115 VAC when 230 VAC is applied, the fuse would blow. If set for 230 VAC when 115 VAC is applied, the unit would detect a low line fault and the summary fault indicator would light. For 230 VAC operation, the three prong side of the power cord supplied must be cut off and replaced with a 230V connector suitable for the available service. See Figure 3-1.

3.3.2 Grounding

It is necessary for personnel and equipment safety to securely ground the amplifier to the station ground bus or to earth ground. The TWTA ground connection is located on the rear panel.

3.3.3 External Connections

If the Remote interface option is included in the TWTA, refer to Section 4.3.7 of this manual for additional detail.


J1 AC PWR IN
FUSE (*)
PROGRAMMED POWER BOARD
AC (L)
AC NEUTRAL (N)
EARTH GROUND (⏚)

(*) FUSE SELECTION

PRIME POWER	FUSE
115V AC	6.25A, SLOBLO
230V AC	3A, SLOBLO

FIGURE 3-1. PRIME POWER CONNECTIONS

3.4 REPACKAGING FOR SHIPMENT

The instructions given below are intended as a general guide for repackaging the TWT amplifier for shipment. A detailed discussion on returning goods can be found on the back of the warranty sheet at the rear of this manual. If you have any questions, contact the Varian field office in your area for assistance.

3.4.1 Shipping Container

Place the system in the original shipping container, making sure that there is adequate packing material around all sides of the system, and that the front panels are protected with thick cardboard strips. If you do not have the original container, use heavy wooden boxes with adequate protection.

3.4.2 Sealing Container

Seal the shipping containers with heavy tape or metal bands.

3.4.3 Marking

Write the words "Fragile", "Delicate Instrument", etc. in several places on the outside of the shipping container.

NOTE

> If the system is to be shipped to Varian for service or repair, attach a tag to it identifying the owner. Also indicate the service or repair desired, the problems encountered and any other information that would be of value to the service facility.

In all correspondence, refer to the unit by both the model and serial numbers.

Please use the following shipping address for all returned products:

Varian Associates
Microwave Components and Subsystems Division
3200 Patrick Henry Drive
Santa Clara, California 95054
Attention: Customer Support

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

This section provides a detailed description of the functions and Theory of Operation of the overall TWTA.

Detailed schematic diagrams for each of the major subassemblies defined in this section are included in Section 6 of this manual and should be used for reference in the following text descriptions.

NOTE

> The reference designations used in the discussions in this section are the same as those on the applicable schematic. The reader should be aware of the fact that the complete reference designation usually requires a prefix to fully identify each compoment. For example, the full reference designation of chassis mounted capacitor C1 whould be UD1C1 which is usually written as 1C1. Similarly, capacitor C1 on the Power Processor Assembly (A2) would be fully identified as 1A2C1. Within the text for a particular assembly, the simplified reference (e.g. C1) is used for components included in that assembly and the full reference designation is used for components external to the assembly being discussed.

Understanding the Theory of Operation of the TWT Amplifier is a necessity for the technician who will maintain the equipment, and an asset for the operator. A thorough understanding of the Theory of Operation of the equipment provides for a more efficient operation, and quicker and more effective repairs if problems develop. This section as well as the guidelines on high voltage and microwave radiation that are contained in the Supplementary Data Section should be completely understood prior to any maintenance activity on the system.

All the available standard options are covered in the discussion of the Theory of Operation of the TWTA even if such options are not included in your specific TWTA (see Section 1.0). Special features (non-standard options) are discussed separately in the Special Features Section of the manual.

4.2 FUNCTIONAL DESCRIPTION

A simplified block diagram of the TWTA (power amplifier) is presented in Figure 4-1. While all of the TWTA components are mounted in a single drawer assembly, it is convenient to discuss the unit in terms of the Power Supply Section and the RF Section. Section 4.2 briefly discusses the functions of the Power Supply and RF sections. Detailed discussions are presented in Section 4.3.

4.2.1 Power Supply Functions

The Power Supply section is designed to accommodate a family of Varian Associates Traveling Wave Tubes (TWTs) with CW RF output power levels ranging from 1 to 20 watts. The major functions of the Power Supply Section are:

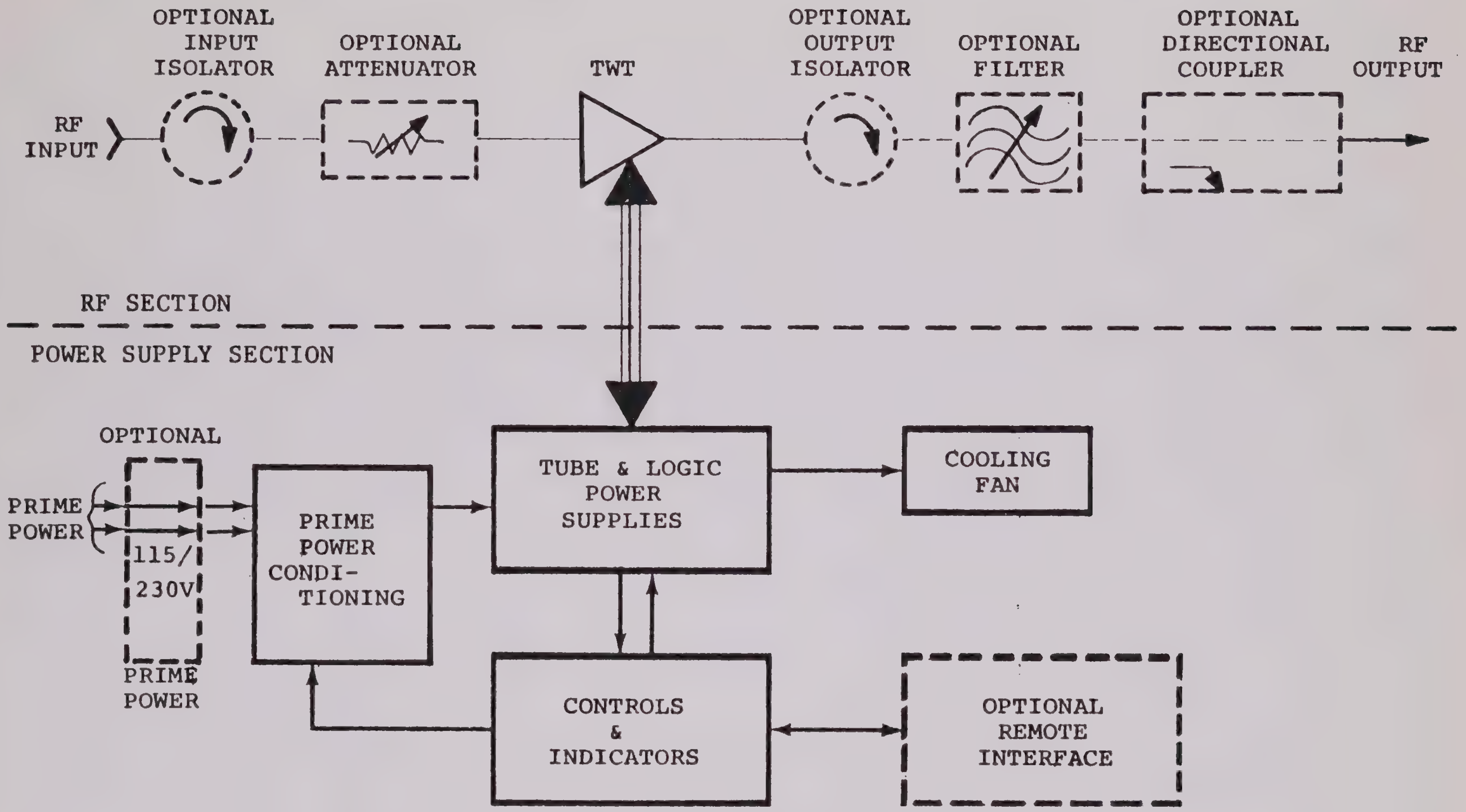

OPTIONAL INPUT ISOLATOR
OPTIONAL ATTENUATOR
TWT
OPTIONAL OUTPUT ISOLATOR
OPTIONAL FILTER
OPTIONAL DIRECTIONAL COUPLER
RF OUTPUT
RF INPUT
RF SECTION
POWER SUPPLY SECTION
OPTIONAL
PRIME POWER
115/ 230V
PRIME POWER
PRIME POWER CONDI- TIONING
TUBE & LOGIC POWER SUPPLIES
COOLING FAN
CONTROLS & INDICATORS
OPTIONAL REMOTE INTERFACE

FIGURE 4-1 FUNCTIONAL BLOCK DIAGRAM-POWER AMPLIFIER

a. Prime Power Interface Circuits: These circuits provide the interface between the prime power source and the Power Processor PCB Assembly. 115 VAC/60 Hz is standard with an option for 115/230 VAC operation available. The prime power interface circuits include input fusing, RFI filtering and input voltage programming required to couple the prime power source (115 VAC or optional 230 VAC) to the Power Supply circuits.

b. High Voltage and Bias Power Supplies: These functions are implemented with two major assemblies, the Power Processor PCB Assembly and the High Voltage Assembly. This portion of the Power Supply circuitry accepts the outputs of the Prime Power Interface circuits and converts prime power into:

    1. The regulated low voltage supplies needed by the protection, control, and indication circuitry.

    2. The high voltage well-regulated supplies required for the TWT.

    3. The low voltage supply needed for the cooling fan.

    4. The low voltage supply needed for power conversion for the high voltage supply.

    5. Grid or anode voltages when required for some of the tube options.

c. Control and Indicator Functions: This portion of the Power Supply provides the circuitry and switches required for control of prime power, TWT high voltage and the optional Local/Remote interface. Status indications are provided that show the operating state of the TWTA and when certain faults occur. A metering function that displays helix current is also provided. An Optional Elapsed Time Meter is available.

d. Cooling : Cooling air is provided by a small fan mounted on the rear of the TWTA. The dominant source of heat within the TWTA is the TWT which is cooled through a heat exchanger by the air flow from the cooling fan. Before entering the heat exchanger duct, most of the air passes across the power supply circuitry to provide cooling.

e. Optional Remote Control Function: The Remote Control Option connects a number of indicators and controls to the Remote Interface connector.

4.2.2 RF Section Functions

The function of the RF Section is to amplify RF signals in the frequency range of interest, consistent with the specifications for the model purchased. The TWT is the active element and exhibits nominal gains of 30 to 60 dB over a relatively wide frequency spectrum. The user has a number of RF options available. The RF Section is designed to accommodate all of these RF options. The available options allow input and/or output isolation, manual control of TWTA RF gain, output filtering and output/reflected power sampling.

4.3 DETAILED DISCUSSION OF POWER SUPPLY SECTION

A block diagram of the Power Supply Section is presented in Figure 4-2. The Power Supply Section consists of the Prime Power Interface Circuits; the Power Processor PCB Assembly; the cooling fan; the High Voltage Assembly; an optional Grid Supply PCB Assembly; an optional Anode Supply PCB Assembly; (the grid and anode supplies are only installed with certain tube options); the control, fault detection and indicator logic; and the Remote Control Interface.

4.3.1 Prime Power Interface

The function of the Prime Power Interface circuits is to match the Power Supply with the prime power source.

The Prime Power Interface circuits include the distribution and protection circuits that are required to match either a 115 VAC (or optionally 230 VAC) 50/60 Hz prime power source to the Power Processor PCB Assembly.

4.3.1.1 Standard Configuration. The basic unit is configured to match a 115 VAC, 50/60 Hz prime power source to the Power Supply.

4.3.1.2 Optional Programmable 115 VAC/230 VAC Operation. When this option is selected, autotransformer T1 is installed on the Main Chassis Assembly 115 VAC or 230 VAC is selected by positioning the PCB internal to the programmable power interface connector (A4) on the rear panel.

4.3.1.3 Fusing. All TWTAs in this series are equipped with an in-line AC fuse and RFI filter. The fuse value is determined by the prime power voltage to be applied. Use a 6.25A slow blow fuse for 115 VAC, a 3A slow blow for 230 VAC operation.

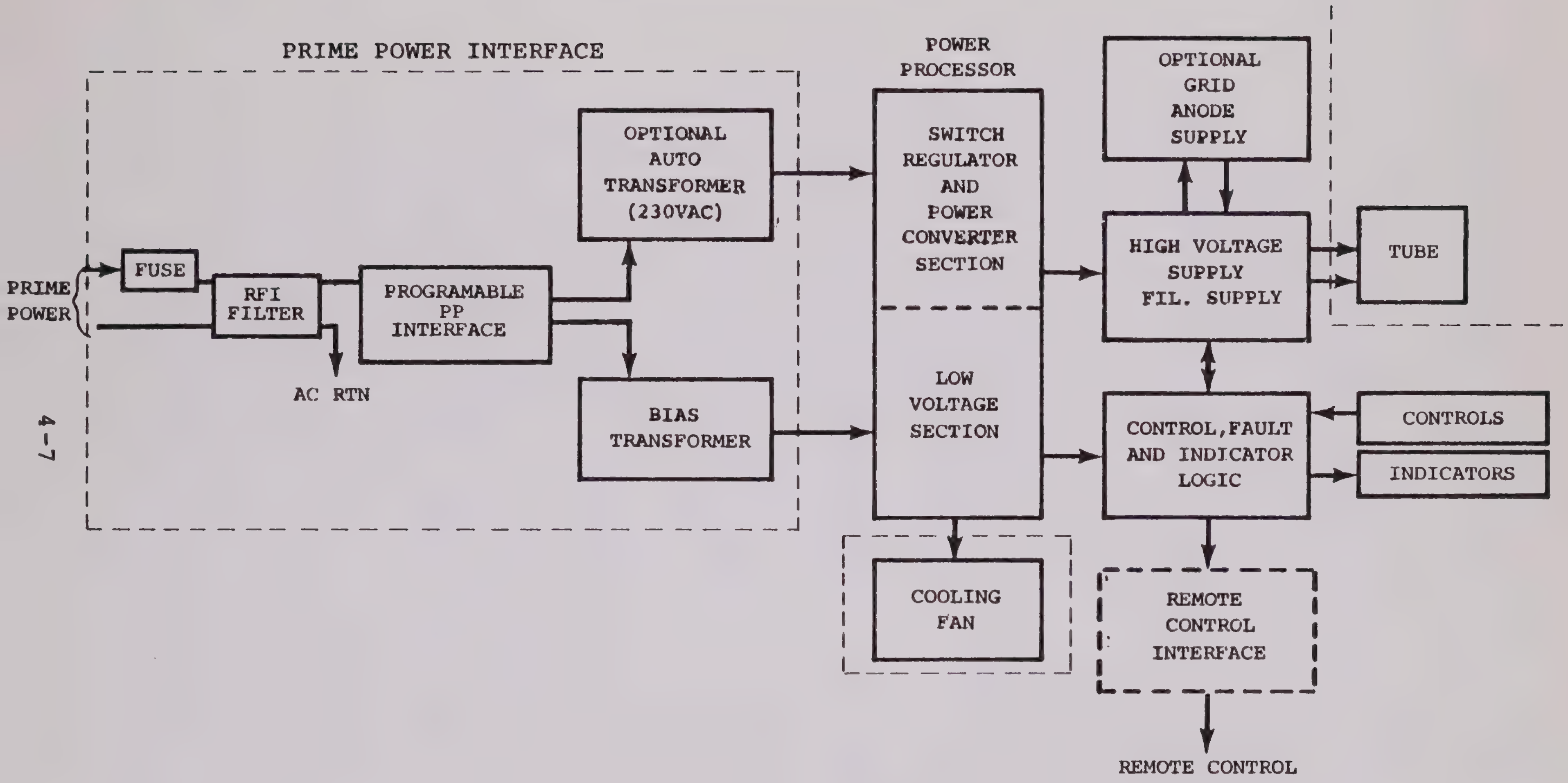

PRIME POWER INTERFACE
PRIME POWER
FUSE
RFI FILTER
AC RTN
PROGRAMABLE PP INTERFACE
OPTIONAL AUTO TRANSFORMER (230VAC)
BIAS TRANSFORMER
POWER PROCESSOR
SWITCH REGULATOR AND POWER CONVERTER SECTION
LOW VOLTAGE SECTION
COOLING FAN
OPTIONAL GRID ANODE SUPPLY
HIGH VOLTAGE SUPPLY FIL. SUPPLY
TUBE
CONTROL, FAULT AND INDICATOR LOGIC
CONTROLS
INDICATORS
REMOTE CONTROL INTERFACE
REMOTE CONTROL

FIGURE 4-2 POWER SUPPLY SECTION BLOCK DIAGRAM

4.3.1.4 Outputs. The outputs of the prime power interface circuits are:

a. 115 VAC for the Switch Regulator, Filament Supply and optional Grid Supply.

b. 18 VAC for the Low Voltage Bias Supplies.

4.3.2 Power Processor PCB Assembly (A2)

NOTE

In the following discussion of the Power Processor Assembly, all reference designations are preceded by 1A2, e.g. the correct designation for R1 on the Power Processor Assembly would be 1A2R1.

4.3.2.1 Function of Power Processor PCB. The Power Processor provides a number of functions as follows:

a. Turn-on surge current limiting by means of a Triac switch and associated control circuit.

b. A bridge rectifier to provide an unregulated 160 VDC bus for the Switch Regulator.

c. A well regulated 60-115 VDC voltage bus needed for the high voltage circuits. A 40 kHz Switch Regulator is used to provide precise voltage

regulation and foldback current control. The foldback current limiting circuits restricts short circuit currents to about 2 amperes and limits Switching Regulator output currents to 4-6 amperes depending on the specific bus voltage selected. The regulation circuits are effective when the Power Processor PCB Assembly is operated alone (i.e. no load condition) or when connected to the High Voltage Assembly.

d. A 20 kHz power converter that chops the regulated bus of the Switch Regulator when the Power Processor is connected to the High Voltage Assembly.

e. A Solid State Feedback Amplifier that senses the high voltage on the tube and adjusts the voltage reference of the Switch Regulator to obtain regulation of the high voltage applied to the tube.

f. An isolated control circuit that allows high voltage to be turned on and off.

g. A bus monitoring circuit that shuts off high voltage if the Switch Regulator bus exceeds a preset value.

h. A line monitor circuit that monitors the prime power voltage level applied to the TWTA and shuts off high voltage if the voltage is too low.

i. A capacitor discharge circuit that discharges the capacitor input to the Switch Regulator anytime prime power is shut off.

j. Regulated low voltage bias supplies needed for the TWTA are as follows:.

1. +15 VDC (referenced to chassis ground) for the cooling fan.
2. +12 VDC (referenced to chassis ground) for the logic and indicator functions and for the HV Feedback Amplifier and turn-on current limiting circuits.
3. ±5 VDC (referenced to the negative rectified line voltage) for the power converter.
4. +12 VDC (referenced to the negative rectified line voltage) for the Switch Regulator and Power Converter.

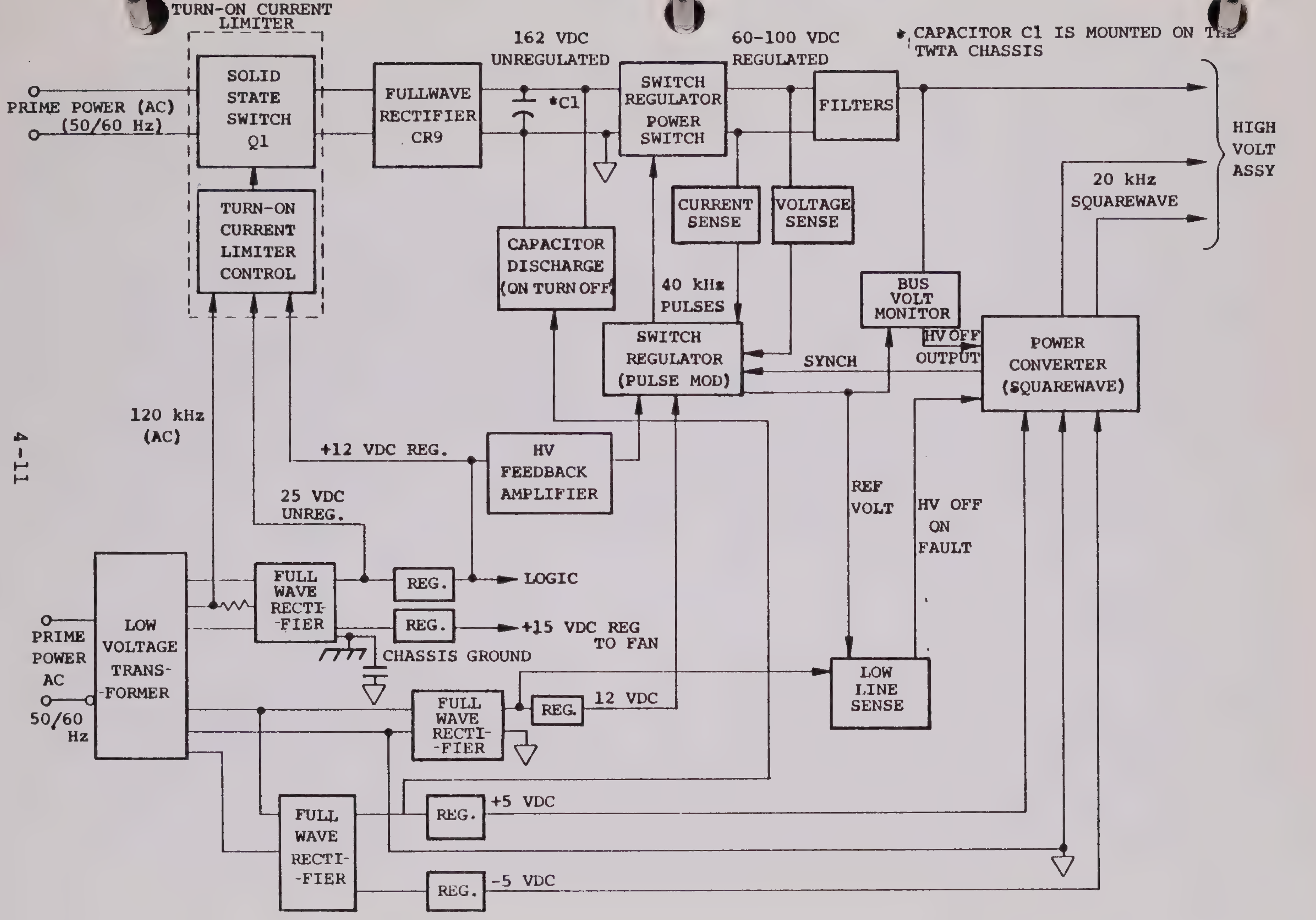
All of these functions are provided on a single printed circuit board that can be tested as an isolated assembly. Test points for troubleshooting are provided on the board. Two adjustable controls allow this board to be set up for any one of the tubes used in this series of TWTAs.

NOTE

> Some of the circuits are not referenced to chassis ground because the power supply is based on the use of an off-line power regulator and converter.

A block diagram of the Power Processor PCB Assembly is presented in Figure 4-3.

4.3.2.2 Turn-On Current Limiting. The function of the turn-on current limiter is to prevent excessive prime power in-rush current during start-up of the TWTA.


TURN-ON CURRENT LIMITER
PRIME POWER (AC) (50/60 Hz)
SOLID STATE SWITCH Q1
TURN-ON CURRENT LIMITER CONTROL
FULLWAVE RECTIFIER CR9
162 VDC UNREGULATED
*C1
SWITCH REGULATOR POWER SWITCH
60-100 VDC REGULATED
FILTERS
HIGH VOLT ASSY
20 kHz SQUAREWAVE
CURRENT SENSE
VOLTAGE SENSE
CAPACITOR DISCHARGE (ON TURN OFF)
40 kHz PULSES
SWITCH REGULATOR (PULSE MOD)
BUS VOLT MONITOR
HV OFF
OUTPUT
SYNCH
POWER CONVERTER (SQUAREWAVE)
120 kHz (AC)
+12 VDC REG.
HV FEEDBACK AMPLIFIER
25 VDC UNREG.
REF VOLT
HV OFF ON FAULT
LOW VOLTAGE TRANS-FORMER
PRIME POWER AC 50/60 Hz
FULL WAVE RECTI-FIER
REG.
LOGIC
REG.
+15 VDC REG TO FAN
CHASSIS GROUND
LOW LINE SENSE
FULL WAVE RECTI-FIER
REG.
12 VDC
FULL WAVE RECTI-FIER
REG.
+5 VDC
REG.
-5 VDC

* CAPACITOR C1 IS MOUNTED ON THE TWTA CHASSIS

FIGURE 4-3 POWER PROCESSOR PCB BLOCK DIAGRAM

The Turn-on Current Limiting circuit is designed to gradually increase the portion of time that AC is applied to full wave rectifier CR9 which is connected across the unregulated bus on the input to the Switching Regulator. Figure 4-4 illustrates the effect of turn-on limiting circuit on the input and output of CR9 during different portions of the start-up cycle. The cross hatched area indicates the time when voltage is actually applied to CR9 and the approximate appearance of the output waveform.

A block diagram of the Turn-on Current Limiter is presented in Figure 4-5.

The Turn-on Current Limiter consists of:

a. A Power Switch, Triac Q1.

b. A diode bridge (CR10) that allows SCR control (via U8) of an AC signal.

c. An optically coupled SCR (U8).

d. A control transistor Q2, and

e. A phase modulating control circuit (U1A, U1B, U1C, U1D).

Power Switch Q1 is in series with the 115 VAC input to CR9. This switch will conduct when an AC signal of proper polarity is applied to gate G of Q1. (Figure 4-5). Everytime the anode potential of Triac Q1 is removed after it has been gated, Q1 stops conducting. This means that every time the AC input voltage to Q1 goes to zero, Q1 stops conducting. If the proper AC signal voltage is applied to gate G, Q1 will conduct as long as the magnitude of the in-phase AC input across Q1 is greater than zero volts. The combination of Q2, U8 and CR10 is used to develop the AC gate signal. Refer to Figure 4-6A.

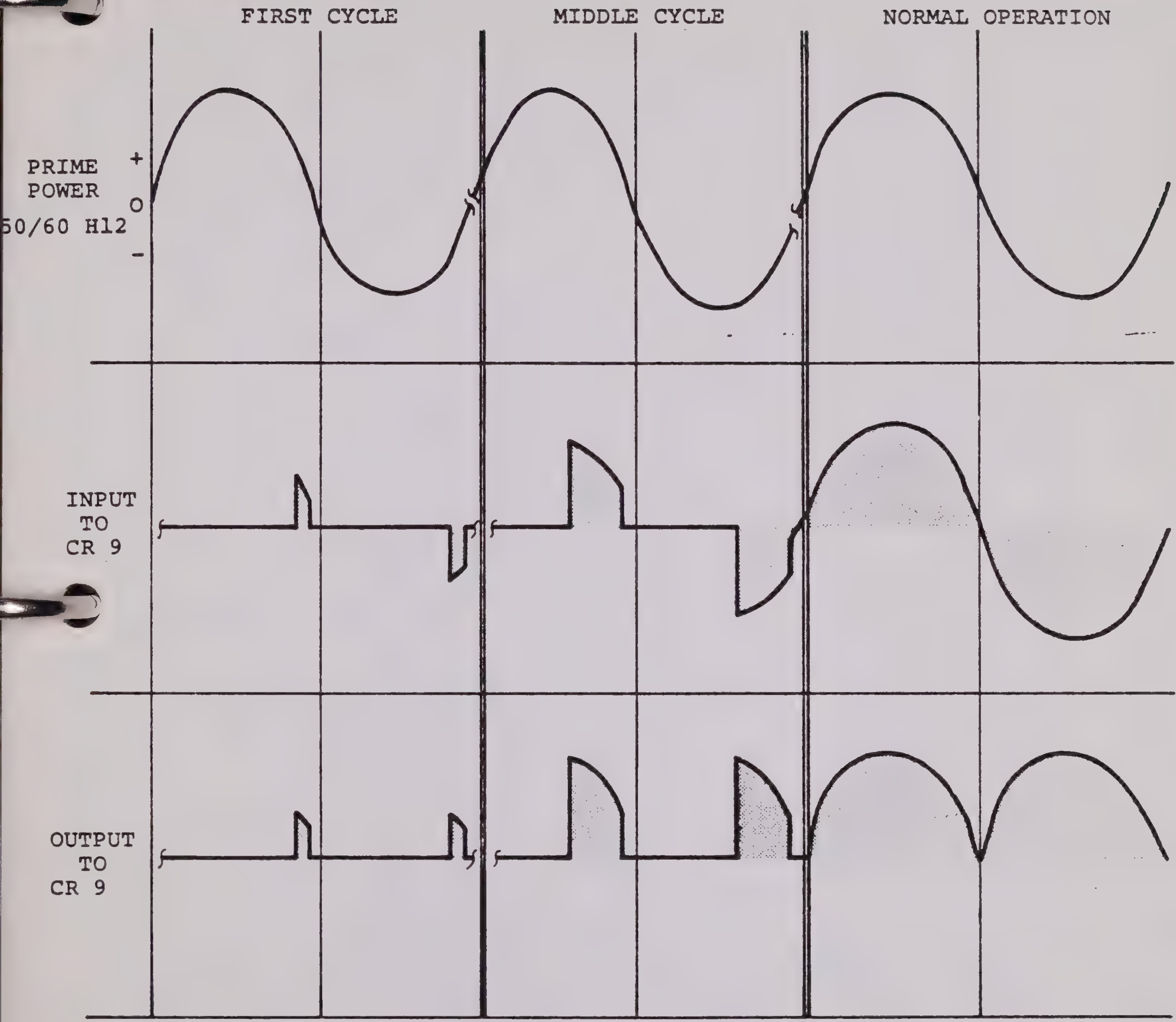

FIRST CYCLE
MIDDLE CYCLE
NORMAL OPERATION
PRIME
POWER
50/60 H12
+
O
-
INPUT
TO
CR 9
OUTPUT
TO
CR 9

FIGURE 4-4 PULSE WIDTH INCREASE DURING TURN ON

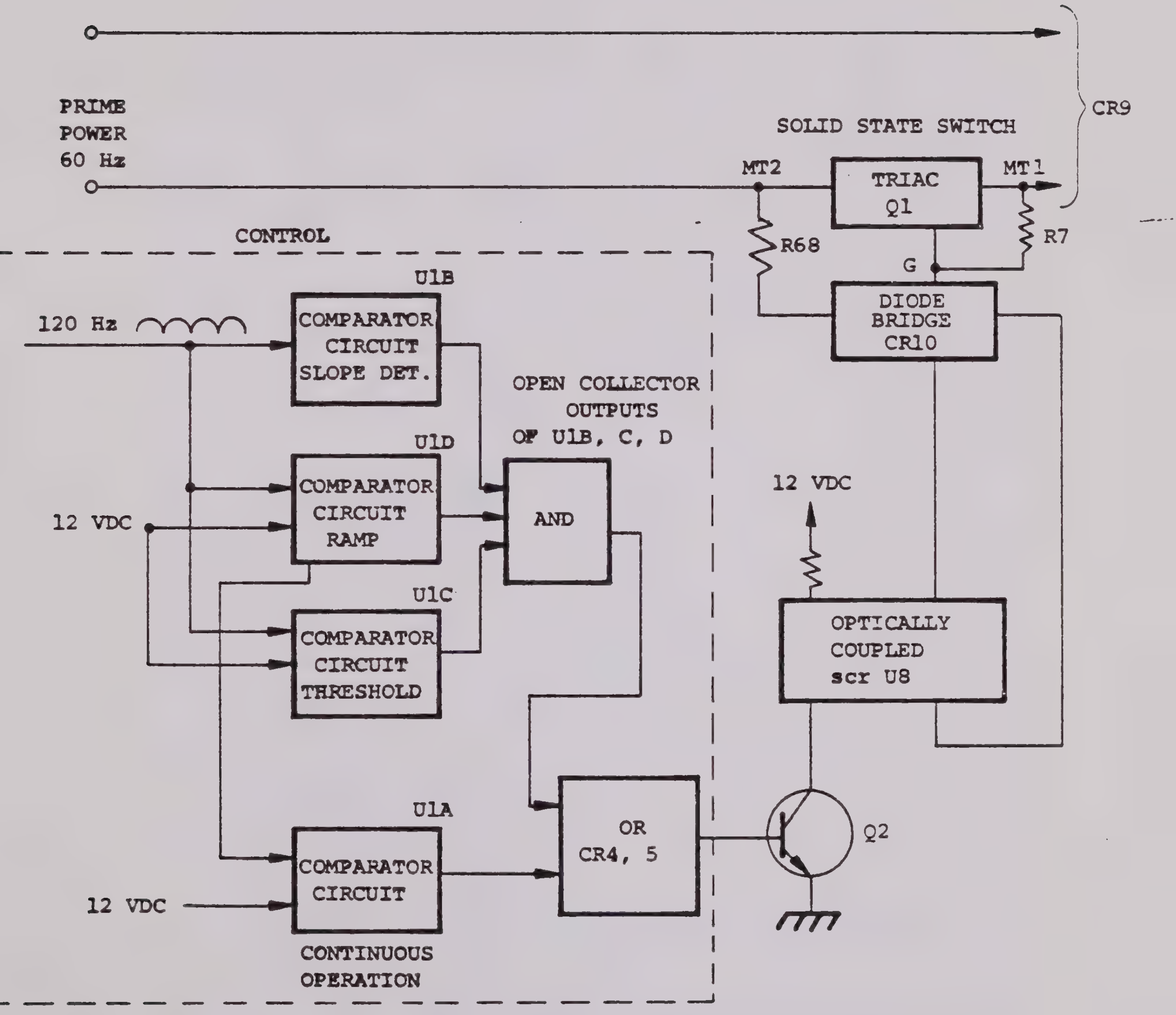
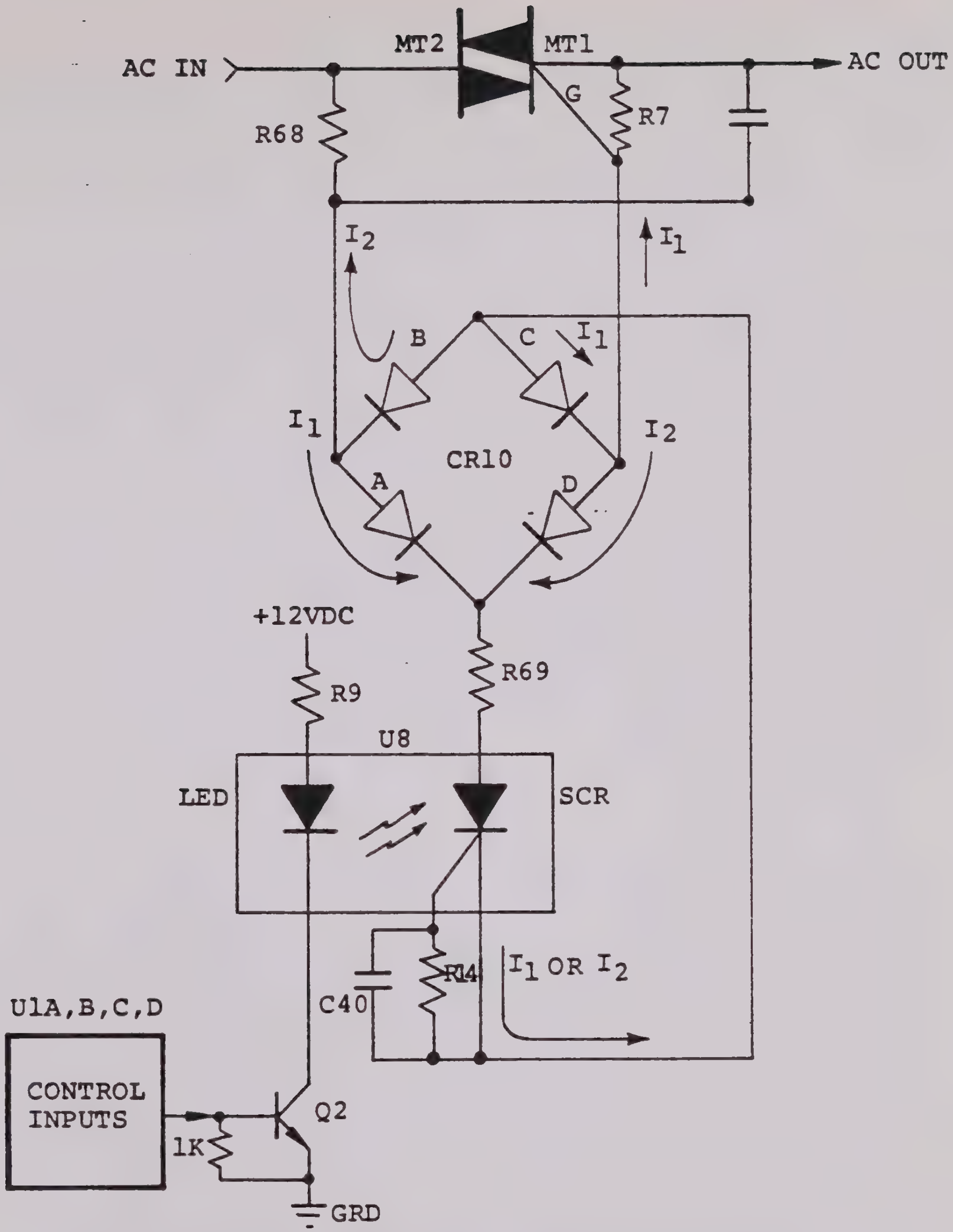
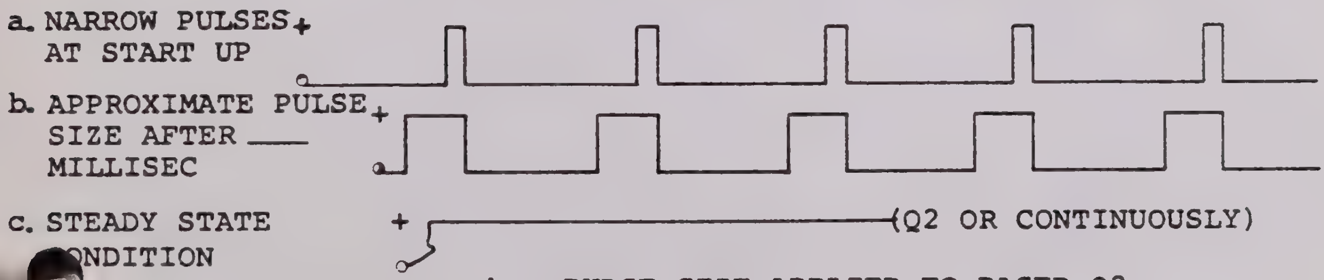

PRIME
POWER
60 Hz
CR9
SOLID STATE SWITCH
MT2
TRIAC
Q1
MT1
R68
R7
G
CONTROL
DIODE
BRIDGE
CR10
U1B
120 Hz
COMPARATOR
CIRCUIT
SLOPE DET.
OPEN COLLECTOR
OUTPUTS
OF U1B, C, D
U1D
COMPARATOR
CIRCUIT
RAMP
AND
12 VDC
12 VDC
U1C
COMPARATOR
CIRCUIT
THRESHOLD
OPTICALLY
COUPLED
scr U8
U1A
OR
CR4, 5
Q2
COMPARATOR
CIRCUIT
12 VDC
CONTINUOUS
OPERATION

FIGURE 4-5 TURN-ON CIRCUITS


AC IN
MT2
MT1
AC OUT
G
R68
R7
I2
I1
B
C
I1
I1
CR10
I2
A
D
+12VDC
R9
R69
U8
LED
SCR
C40
R14
I1 OR I2
U1A,B,C,D
CONTROL INPUTS
Q2
1K
GRD

a. BASIC CIRCUITS FOR GATING TRIAC Q1


a. NARROW PULSES AT START UP
+
b. APPROXIMATE PULSE SIZE AFTER ____ MILLISEC
+
c. STEADY STATE ONDITION
+
(Q2 OR CONTINUOUSLY)

b. PULSE SIZE APPLIED TO BASED Q2

FIGURE 4-6 POWER SWITCH CIRCUIT OPERATION

For discussion purposes, consider the AC input shown in Figure 4-6 as being divided into half cycle #1 and half cycle #2. As the magnitude of the signal increases during half cycle #1, current I_1 would increase and follow the circuit path indicated in Figure 4-6.

The current path during half cycle #1 would be through R68, diode CR10 A of CR10, R69, the SCR portion of U8, diode C of CR10 and to gate G. During half cycle #2, the current would flow in the opposite direction and through diodes CR10 D and B.

Currents I_1 and I_2 can only flow if the SCR portion of U8 is ON. The SCR portion of U8 acts as a latching switch during each half cycle. The switching action is controlled by the LED portion of U8. Transistor Q2 controls the LED portion of U8. When Q2 is on, current flows through the LED portion of U8 which emits light that actuates the SCR portion of U8 (i.e., U8 is an optically coupled SCR).

Q2 operation is established by the control input circuits (U1A, U1B, U1C, U1D). The function of the control input circuits is to limit the portion of time that Q1 conducts AC current during each half cycle until the start up cycle is complete and then operate Q2 with a 100% duty cycle. This is achieved by turning Q2 on with pulses that become longer as a function of time. At some point (steady state operation) a constant DC signal is automatically applied to drive Q2.

The block designated Control Inputs in Figure 4-6 consists of the four different circuits shown in Figure 4-5. These circuits are identified in the Power Processor PCB Assembly schematic as the Slope detector (U1B), the Ramp Detector (U1D), the Threshold Detector (U1C) and the CW Control (U1A). All of these circuits are based on the use of a voltage comparator which has a logic high output when the voltage on the comparator plus (+) input is greater than that on the comparator minus (-) input.

Q2 can be turned on by a logic high from either U1A or the combination of U1B, C and D. The function of U1A (CW Control) is to turn Q2 on after a preset delay period. When the TWTA is turned on, the plus (+) input of U1A is pulled to ground by capacitor C3 which is fully discharged at turn-on. The minus (-) input of U1A is tied to the 12 VDC bias through R2. Since the voltage on the minus input is about 11.5V and the voltage on the plus side is zero, the output of U1A is low. C3 charges at a rate set by R1 and C3 (about 100 millisecs). When C3 is fully charged, CR1 pulls U1A-5 to 12 VDC and the output of U1A goes high turning Q2 on via CR5.

U1B, U1C and U1D form an AND circuit whose function is to gate Q2 on for increasing periods of time until the CW control circuit takes over control of Q2. The outputs of U1B, C and D are open collector circuits that connect to Q2 via CR4.

a. Slope Detector (U1B). This circuit is designed to permit a high output during the negative going portion of each cycle (see Fig. 4-7a). Both inputs of U1B are connected to the same 9 VAC 120 Hz signal. The purpose of R3 and C2 is to introduce a delay on the plus input (U1B-7) to guarantee that U1B will not go high before the beginning of the negative going portion of the AC signal (See Figure 4-7b). C2 holds U1-7 at a value that is lower than U1-6 when the signal is increasing and higher than U1-6 when the signal is decreasing. If U1B operated alone the result would be a pulse like that shown in Figure 4-7B. The signal applied to U1B is taken from the center tap of 1T1 and reflects the action of CR3 which results in a 120 Hz signal as seen by U1B. As a result, the output of U1B would go high on each half cycle of the 50/60 Hz input to T1 as shown

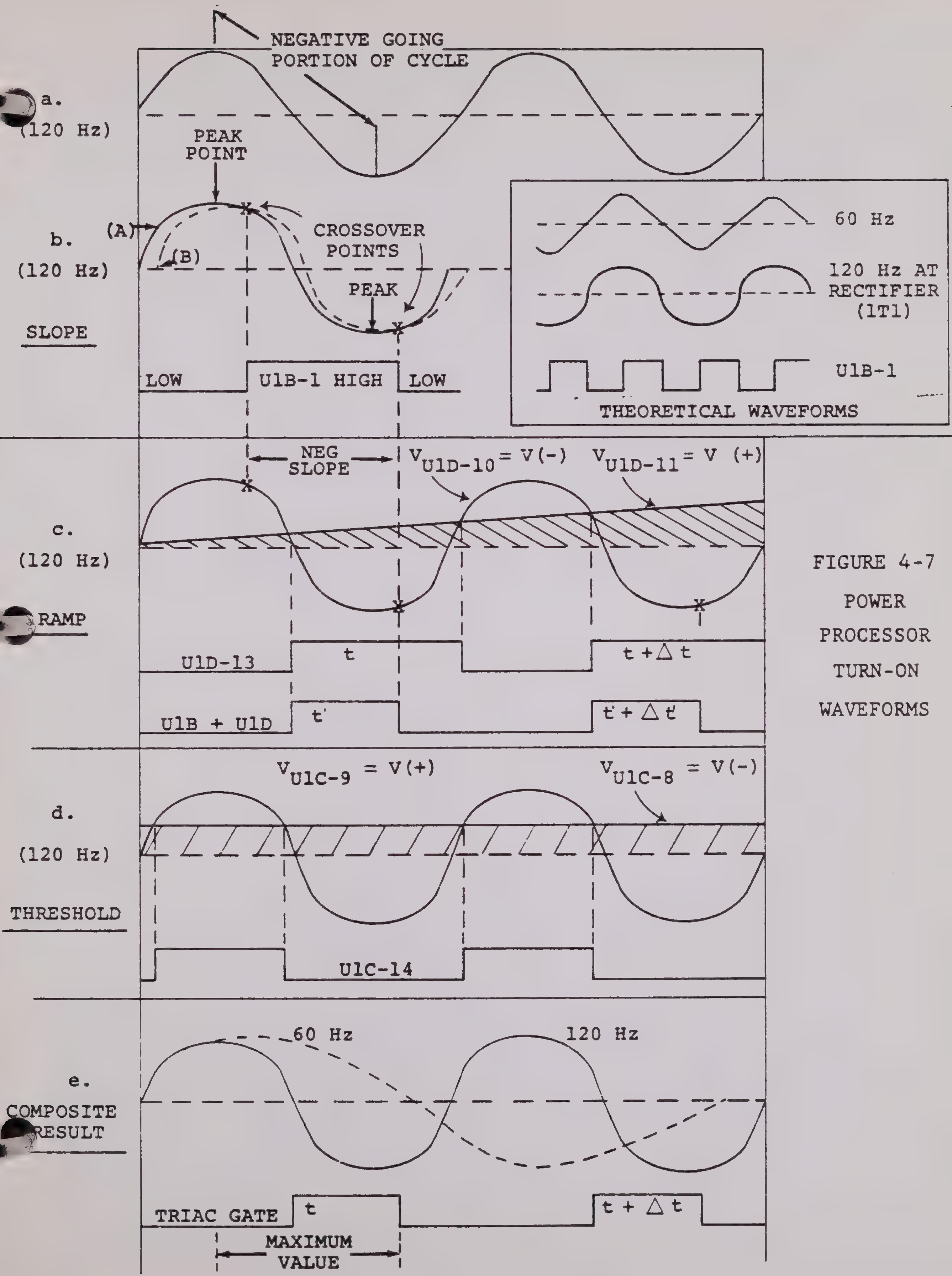

NEGATIVE GOING
PORTION OF CYCLE
a.
(120 Hz)
PEAK
POINT
(A)
(B)
b.
(120 Hz)
CROSSOVER
POINTS
PEAK
SLOPE
LOW
U1B-1 HIGH
LOW
60 Hz
120 Hz AT
RECTIFIER
(1T1)
U1B-1
THEORETICAL WAVEFORMS
NEG
SLOPE
$V_{U1D-10} = V(-)$
$V_{U1D-11} = V\ (+)$
c.
(120 Hz)
RAMP
U1D-13
t
t + Δ t
U1B + U1D
t'
t' + Δ t'
$V_{U1C-9} = V(+)$
$V_{U1C-8} = V(-)$
d.
(120 Hz)
THRESHOLD
U1C-14
60 Hz
120 Hz
e.
COMPOSITE
RESULT
TRIAC GATE
t
t + Δ t
MAXIMUM
VALUE

FIGURE 4-7

POWER

PROCESSOR

TURN-ON

WAVEFORMS

in Figure 4-7b. Since U1B-1 (an open collector) is tied to the outputs of U1C and D, the waveforms shown in Fig. 4-7b are not actually seen during normal operation of the Power Processor PCB Assembly.

b. Ramp Detector U1D. This circuit is designed to turn U1D on for longer and longer periods of time as a function of the charge on capacitor C3. As C3 charges, the voltage on U1D-11 increases. The other input of U1D (U1D-10) senses the same 120 Hz AC line that was sensed by U1B (refer to Fig. 4-7c). This shows the increase in the voltage on U1D-11 in exaggerated terms. Each succeeding cycle V(-) is larger than V(+) for shorter periods of time which results in the output of U1D going high for longer and longer periods of time. Remember that the slope detector only worked a portion of the time (X-Slope-X) in Figure 4-7c. The combined result of U1B and U1D would be something like that shown in Figure 4-7c.

c. Threshold Detector. This circuit limits the time when the output of U1C goes high to a portion of the positive half cycle of each 120 Hz cycle (Figure 4-7d). V(+) senses the 120 Hz signal and V(-) senses the 12 VDC bus. The divider string of R2, R4, R5 is used to reduce the V(-) reference voltage to about 1/2 volt. This keeps the output of U1C low during the zero cross-over points of the 50/60 Hz prime power cycle.

The composite of the three circuits (U1B, C, D) is shown in Figure 4-7e. The result is a pulse that starts earlier each half cycle of the 60 Hz cycle and cuts off before the zero cross-over point of the 60 Hz input. The maximum value of the pulse width is set by the Slope Detector (U1B) to be less than 1/4 of the 60 Hz signal cycle time.

The net result is that Q2 is turned on for very short periods during the early stages of start-up, the periods increase to a value just short of as 50% duty cycle until the CW Control Circuit is actuated and then Q2 operates with a 100% duty cycle. This combination of circuits presents excessive in-rush current with a minimum of energy losses as compared to dissipative type circuits.

4.3.2.3 Bus Rectifier. A 160 VDC unregulated bus is required as an input to the Switch Regulator on the Power Processor PCB Assembly. This bus is generated by the combination of CR9 and capacitor 1C1. (1C1 is mounted on the chassis of the TWTA). The 115 VAC output of the Turn-on Limiter is fed to bridge rectifier CR9 and filtered by capacitor C1. As a safety measure, C1 is discharged by a special circuit whenever the TWTA is turned off. Figure 4-8 is a simplified schematic of the Bus Rectifier, capacitance filter and discharge circuit. In normal operation, the combination of R73 and R74 (1K each) bias the base of Q18 to about 6.3 volts and Q18 is turned on. When Q18 is on, this pulls the base of Q16 low and Q16 and Q17 are off. When the TWTA is turned off the unregulated 12.7 VDC bus rapidly decays. When this bus voltage falls below 2 VDC, Q18 shuts off and Q16 and Q17 turn-on. When Q17 is turned on 1C1 is discharged through R77 (390 ohms).

4.3.2.4 Switch Regulator. The Switch Regulator provides a well regulated, adjustable 60 to 115 VDC bus that is used to drive the High Voltage Assembly. A simplified block diagram of the Switch Regulator is presented in Figure 4-9. The Switch Regulator provides the following:

a. A well regulated (0.2%) DC bus that is adjustable over the range of 60 to 115 VDC.

b. Regulated Bus output under load or no-load conditions. (This is referred to as pre-regulation since overall regulation is obtained by feedback from the high voltage output to the TWT).

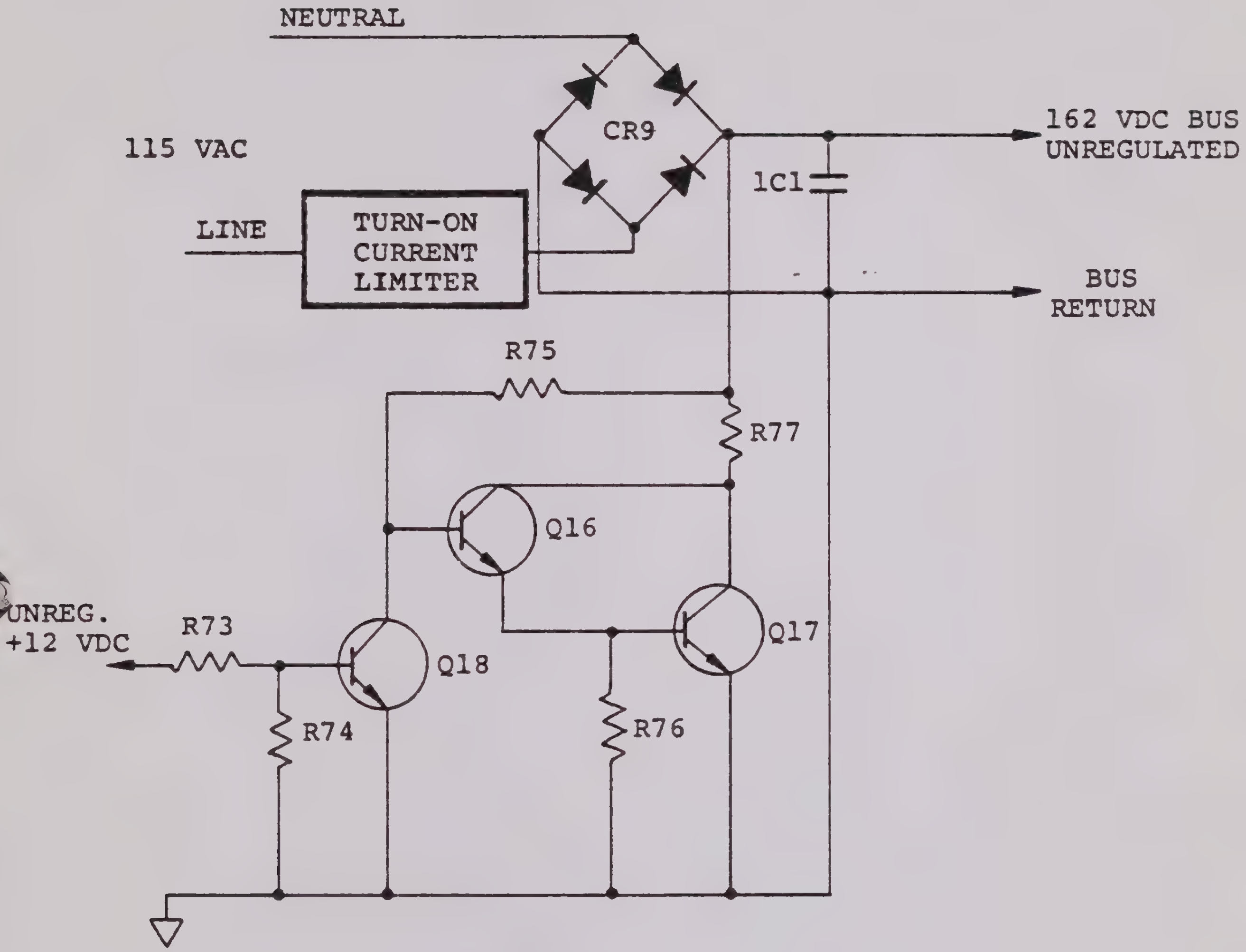

NEUTRAL
115 VAC
LINE
TURN-ON CURRENT LIMITER
CR9
1C1
162 VDC BUS UNREGULATED
BUS RETURN
R75
R77
Q16
Q17
Q18
UNREG. +12 VDC
R73
R74
R76

FIGURE 4-8 BUS RECTIFIER SIMPLIFIED SCHEMATIC

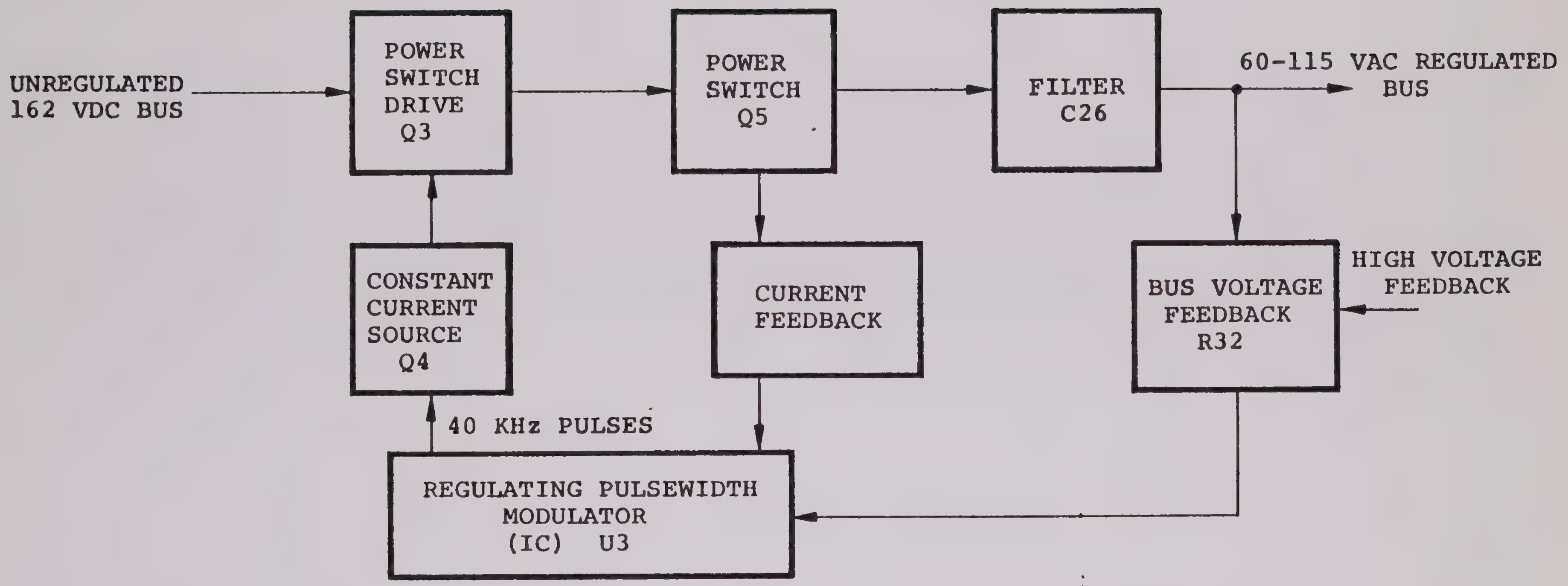

UNREGULATED
162 VDC BUS
POWER SWITCH DRIVE Q3
POWER SWITCH Q5
FILTER C26
60-115 VAC REGULATED BUS
CONSTANT CURRENT SOURCE Q4
CURRENT FEEDBACK
BUS VOLTAGE FEEDBACK R32
HIGH VOLTAGE FEEDBACK
40 KHz PULSES
REGULATING PULSEWIDTH MODULATOR (IC) U3

FIGURE 4-9 SIMPLIFIED BLOCK DIAGRAM-SWITCH REGULATOR

c. Current limiting with foldback that limits short circuit currents to 2 amperes and normal operating currents to the range of 4 to 6 amperes depending on the bus voltage selected.

d. Regulation of the high voltages applied to the TWT during normal operation.

Integrated circuit U3 is the focal point of the Switch Regulator. A simplified schematic of U3 is presented in Figure 4-10.

U3 incorporates a combination of circuits that produce pulses on the collector/emitter of a pair of transistors that operate 180° out of phase with each other. The frequency of these pulses is established by an internal oscillator which is controlled by an external R/C network. These pulses can be used as separate outputs (e.g. 20 kHz on C_A/E_A and 20 kHz on C_B/E_B) or can be added together to form a pulsed output at twice the frequency (e.g. the two 20 kHz pulse outputs when combined would be 40 kHz.) The width of the pulses is controlled by an internal comparator.

One input of this comparator is driven by the ramp signal that is generated by the internal oscillator. The other comparator input (sense input) is connected to the output of three internal circuits, an error amplifier, a current limiter and a shut-down circuit. Keep in mind the fact that the internal comparator varies the width of the output pulse train in response to signals from the three control circuits.

A low signal on the compensation point (pin 9) from any one of the these three circuits causes the output of the comparator to go proportionally high. This output is inverted by the two NOR circuits feeding QA and QB and turns off QA and QB until the internal comparator output goes low again.

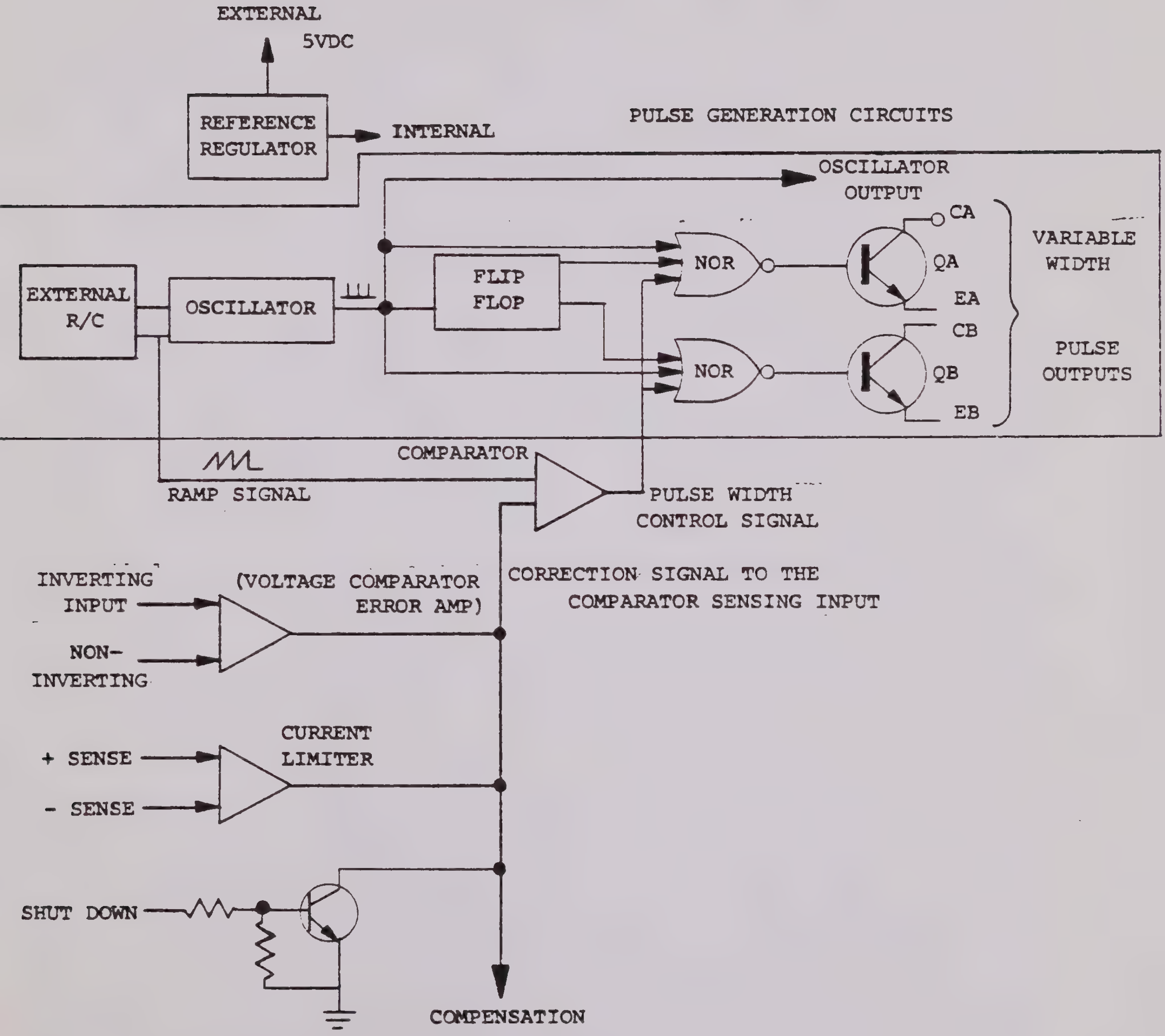

EXTERNAL
5VDC
REFERENCE REGULATOR
INTERNAL
PULSE GENERATION CIRCUITS
OSCILLATOR OUTPUT
CA
VARIABLE WIDTH
EXTERNAL R/C
OSCILLATOR
FLIP FLOP
NOR
QA
EA
CB
NOR
QB
EB
PULSE OUTPUTS
COMPARATOR
RAMP SIGNAL
PULSE WIDTH CONTROL SIGNAL
INVERTING INPUT
(VOLTAGE COMPARATOR ERROR AMP)
CORRECTION SIGNAL TO THE COMPARATOR SENSING INPUT
NON-INVERTING
CURRENT LIMITER
+ SENSE
- SENSE
SHUT DOWN
COMPENSATION

FIGURE 4-10 BLOCK DIAGRAM SWITCH REGULATOR IC

The same IC is used for the Switch Regulator and the Power Converter (section 3.3.2.6). In the Switch Regulator, the shut down circuit is not used (SD tied to ground) and the outputs of QA and QB are tied together to provide a 40 kHz pulse train.

U3 is set to oscillate at a frequency lower than that of Power Converter IC U4. The characteristics of this IC are such that if a higher frequency signal is applied to the Sync input (pin 3) of U3, the oscillator will be forced to operate at this higher frequency. C19 and R21 set the time constant for U3 and C34 and R55 control U4. Since both capacitors are the same and R21 is 3.9K while R55 of U4 is 3.32 K, U3 would operate at a rate that is lower than that of U4 if there was no sync signal from U4.

Refer back to Figure 4-9 which indicates a 40 kHz output from U3 driving a constant current source (when Q4 is ON) consisting of Q4 and R26. This circuit matches U3 which is a low voltage device with the relatively high voltage unregulated bus and provides immunity to line voltage variations.

Transistor Q3 is used to provide the current amplification needed to operate Power Switch Q5. The combination of L1, R12 and R13, which are associated with Q3, provides for sharp cut off of Q5 which results in faster switching times and thus higher regulation efficiency.

The primary power switching circuit consists of Q5, and R20. Q3 acts as a switch to turn Q5 on and off. During the time that Q5 is on, the current delivered to L2 is increasing. When Q5 is shut off this current starts to decay. C26 stores the charge delivered via L2. When Q5 is off, the stored energy in L2 starts to release in such a way as to continue the current flow in the same direction in the loop formed by L2, C26, and CR13. Output voltage and output current are sensed to regulate the output bus.

a. Output Voltage Sensing. As discussed earlier, U3 includes an error amplifier that is used to monitor the bus voltage established by Q5. Figure 4-11 presents a simplified schematic of the Voltage Regulator circuits. The error amplifier reference voltage is established with resistors R35 and R36 to about +3.3 VDC. This is applied to the non-inverting input (U3-2) of the error amp. The bus voltage is sampled and divided down with resistor string R72 and R33. R33 allows adjustment of the output bus voltage. The sample voltage is applied to the inverting input of the error amplifier via R30. R33 is adjusted to balance the two inputs at the desired output bus voltage. As noted earlier, when the error amplifier output goes high, the pulse width of the drive to the power switch gets longer and when the output goes low the pulse width gets shorter. Therefore, when the sense voltage on R33 goes high this effect is inverted and the pulse width gets smaller which reduces the bus voltage until the error amplifier inputs balance. Similarly, a decrease in the voltage on R33 results in larger pulse widths until balance is achieved.

The combination of C21, R70, R71, and C42 are used to provide proper loop stability. The combination of R29, C24 and R30 reduce the effects of high frequency noise. R72 and C27 provide a lead network to obtain proper feedback stability.

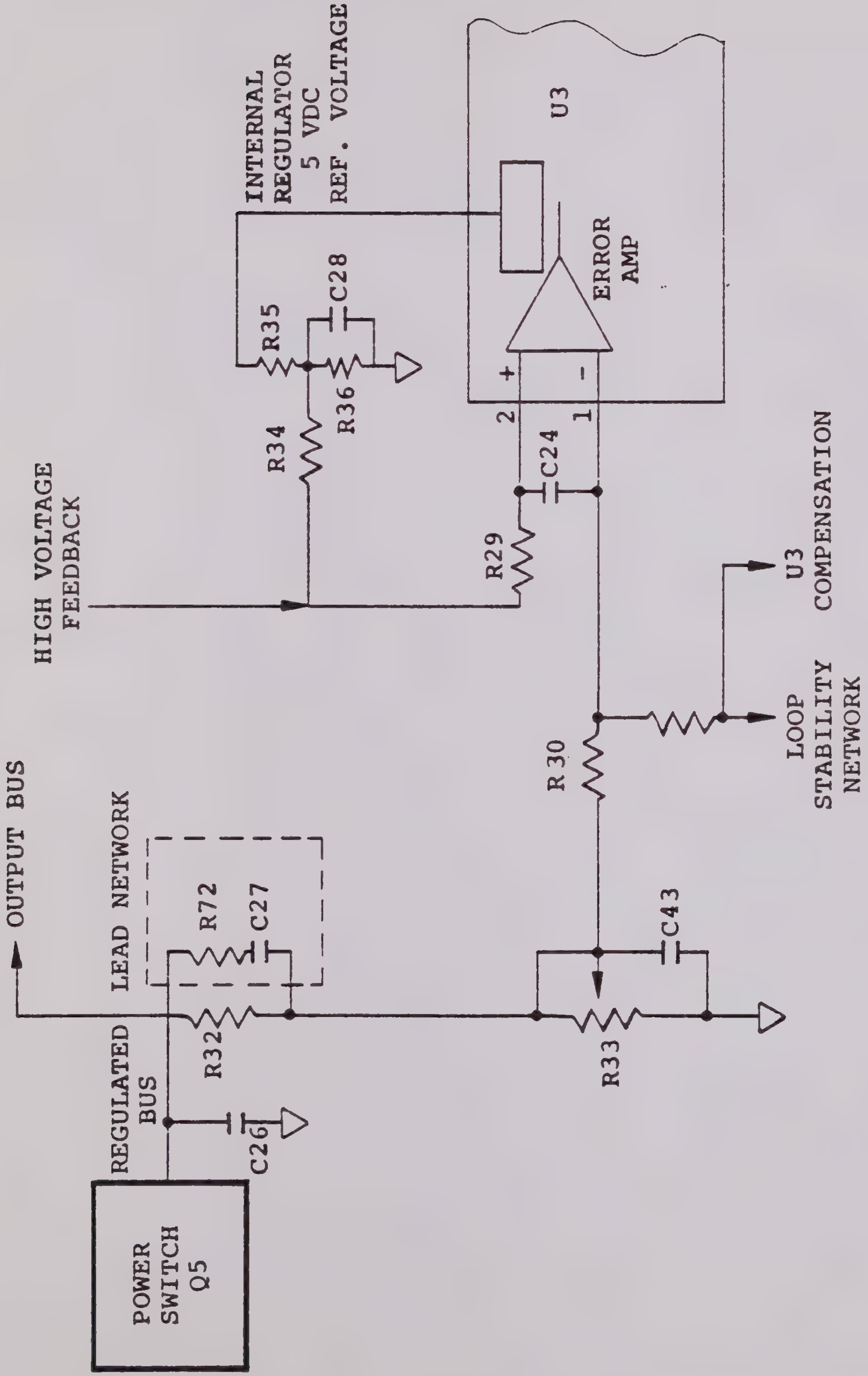

OUTPUT BUS
LEAD NETWORK
REGULATED BUS
POWER SWITCH Q5
R72
C27
R32
C26
R33
C43
R30
HIGH VOLTAGE FEEDBACK
R34
R35
R36
C28
R29
C24
2
1
+
-
INTERNAL REGULATOR 5 VDC REF. VOLTAGE
ERROR AMP
U3
LOOP STABILITY NETWORK
U3 COMPENSATION

FIGURE 4-11 SIMPLIFIED SCHEMATIC-OUTPUT BUS VOLTAGE REGULATION CIRCUIT

b. Current Limiting. The function of the Foldback Limiting Circuit is to limit the current output of the Switch Regulator. This subsequently limits current through the Power Inverter and High Voltage Supplies. In Figure 4-12 the transistor marked QA is used to sense the voltage between point (A) on QA and point (B). Es is selected so that during normal operation QA is turned off. When QA is turned on, the width of the pulses from U3 are reduced. QA operates with a built in threshold of 0.2 VDC.

R25 is used to monitor Switch Regulator current. One ampere equals 0.1V, 2 amps = 0.2V and 5 amps = 0.5V. If the regulator bus was shorted to the load return, the regulator bus voltage would approach zero and E1 would approach zero. Therefore, the voltage on pont A would essentially be that across R25 (E2). As the short circuit current increases above 2 amps Es becomes approximately -0.2V and QA turns on. This results in a signal to the comparator that in turn reduces the width of the pulse from U3 to the power switch. The result is that Switch Regulator current is limited to about 2 amperes. When the bus voltage (Eb) is not zero, a positive voltage (E1) is developed across R24. Assume that Eb is +100 VDC, then voltage E1 would be 0.003 amps x 100 ohms = +0.3 VDC. Since Es = 0.3V (E1) + (E2) and E2 = -I x R25, the operating current must be at least 5 amperes if Es is to be -0.2 VDC. When this occurs, U3 pulse widths are reduced which causes a reduction in bus voltage Eb. Now it takes less current to keep Es at -0.2 VDC and QA generates a signal to further reduce Eb. The result is that the Switch Regulator output current finally drops to 2 amperes and EBV approaches zero (see graph in

Figure 4-12). This progressive cycle is known as current foldback, therefore, the current limiter of the Switch Regulator is described as as foldback current limiter.

The function of transistor Q8 (Figure 4-12) is to provide temperature compensation for the current limiter.

4.3.2.5 High Voltage Feedback. The function of this circuit is to provide for direct regulation of the high voltage output to the TWT. The signal from the High Voltage Assembly is compared against an adjustable reference and generates an error signal that can be used to control U3. This circuit also isolates the high voltage feedback signal from the error amplifier of U3.

U9 is the High Voltage Feedback Amplifier. A voltage proportional to the high voltage applied to the TWT is fed back from the High Voltage Assembly to the Power Processor PCB Assembly. The feedback voltage is a few volts above ground potential. This voltage is applied to one input of U9 (pin 2) and compared to the reference voltage on U9-3. The reference voltage on U9-3 can be adjusted over a fairly wide range with resistor R19. Zener CR11 is used to provide a stable regulated reference voltage across R19. When the high voltage feedback signal increases or decreases with respect to the balanced condition, the output of U9 will change proportionally. This change is amplified by transistor Q6 and fed to optical coupler U5. The output of U5 is connected to the reference point of the error amplifier of U3. An increase in the reference voltage of U3 drives the bus higher and vice-a-versa.

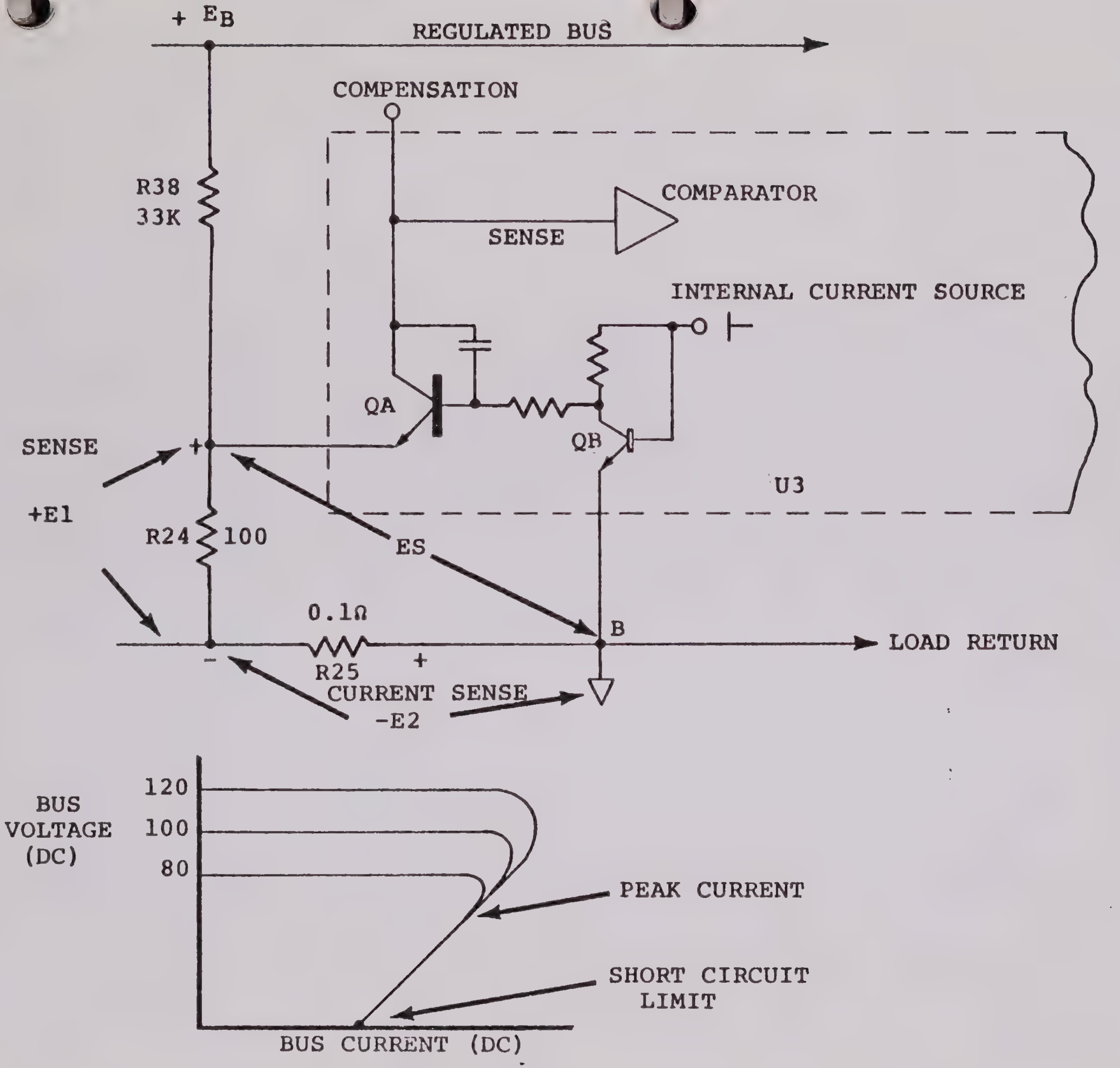

+ E_B
REGULATED BUS
COMPENSATION
R38
33K
COMPARATOR
SENSE
INTERNAL CURRENT SOURCE
QA
QB
SENSE
+
+E1
U3
R24
100
ES
0.1Ω
B
LOAD RETURN
-
R25
+
CURRENT SENSE
-E2
BUS
VOLTAGE
(DC)
120
100
80
PEAK CURRENT
SHORT CIRCUIT
LIMIT
BUS CURRENT (DC)

FIGURE 4-12 SIMPLIFIED SCHEMATIC-SWITCH REGULATOR CURRENT LIMITER

4.3.2.6 Power Converter Drive. The function of this circuit is to convert the regulated DC bus generated by the switch regulator into a regulated 20 KHz AC BUS that is then applied to the High Voltage transformer of the High Voltage Assembly. The Power Processor PCB Assembly generates both the regulated DC bus and the low voltage power converter drive signals. The Power Converter transformer is part of the High Voltage Assembly.

U4 is the same IC as U3. U4 is set up to generate a 20 kHz output on both U3CA and U3CB. This frequency is established by C34 and R55 and is also used to synchronize U3. The combination of R50 and R51 estasblishes a 4 microsecond dead time to assure time separation of the two out of phase pulse signals on U3CA and U3CB.

U4 includes a shut down feature (pin 10). When U4-10 is high the output of U4 shuts off. OP Amp U2 controls the signal on U4-10. ICs U3 and U4 both incorporate an internal +5V reference. The reference voltage of U3 is sensed by U2C (pin 9). The other comparator leg of OP Amp U2C (pin 8) is connected to the output stage of optical coupler U6. When U6 is energized, U6-4/5 acts as a switch and connects U2C-8 to +12 VDC.. A high voltage ON command (a logic high) turns U6 on. A high on U2C-8 forces the output of U2C low (pin 14) and allows U4 to generate the 20 kHz outputs on U4-CA/Cb. The 20 kHz signals from U4 are fed to two pairs of amplifiers (Q8, Q9, Q10, Q11 and Q12, Q13, Q14 and Q15). The outputs of these stages are two high current 20 kHz outputs that are connected to the High Voltage transformer of the HV Assembly.

4.3.2.7 Line and Bias Voltage Monitors. Low line and bias overvoltage detection circuits are included in the Power Processor PCB Assembly. The sense line of U2D (pin 10) is connected to the output of CR2 (approx. 25 VDC) and dropped to about 6.5 VDC by resistor R39 and R40. The reference input of U2D (pin 11) is connected to the +5 VDC reference of U3. As long as the sense

line stays high the output of U2D (pin 13) stays low, and holds Q7 off. If U2D-10 goes low, Q7 turns on, pulls the compensation input (pin 9) of the error amplifier of U4 low, and shuts off the output of U4. When the output of U2D-2 goes high it also energizes U7, which generates a low line fault signal that goes to the logic board fault detector.

U2B-6 monitors the switch regulator bus when the bus voltage goes too high (over 115 VDC) the output of U2B-1 goes low which pulls the sense lines of U2A-10 low and the output of U2A-13 goes high which energizes U7.

4.3.2.8 Low Voltage Supplies. The Power Processor PCB Assembly provides the four low voltage bias supplies required for the TWTA. These supplies operate in pairs. Two (+12 VDC and ±5 VDC) are driven by the secondary of transformer T2 and CR2, two (+12, +15 VDC) are connected to output of CR3.

The nominal output of CR2 is 12.7 VDC. This voltage is applied to a pair of capacitors (C7, C8) and regulators U11 and U12 to develop +5 V and -5 VDC respectively. The junction of C7 and C8 is tied to the center tap of the secondary of transformer T1 (-7 VAC). This supply provides the base drive voltages for the converter transistors Q11 and Q12.

The voltage between 1T2-7 and 1T2-8 is applied to a voltage doubler formed by C4, C6 and diodes CR6, CR8, CR7. The output of the doubler is about 25 VDC which is sensed through resistors R39 and R40 by low-line detector U2D-10. This voltage is applied to regulator U10 to develop the 12 VDC bus used to power switch regulator ICs U3 and U4.

The other secondary of 1T2 is connected to CR3 and generates an output voltage of approximately 25 VDC which is applied to

regulators U13 and U14. U13 supplies a regulated 15 VDC bus for the cooling fan. U14 provides +12 VDC for the input current limiting circuits, the HV feedback circuits and the Remote Control interface.

4.3.3 Logic PCB Assembly (A2) Functions

NOTE

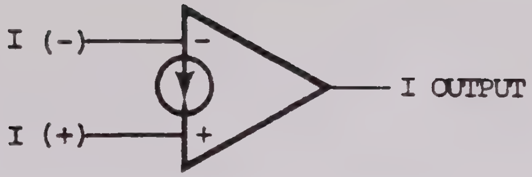
> In the following discussion of the Logic PCB Assembly, all reference designations are preceded by 1A3, e.g., the correct designation for R1 is 1A3R1.

The Logic PCB Assembly provides the following functions:

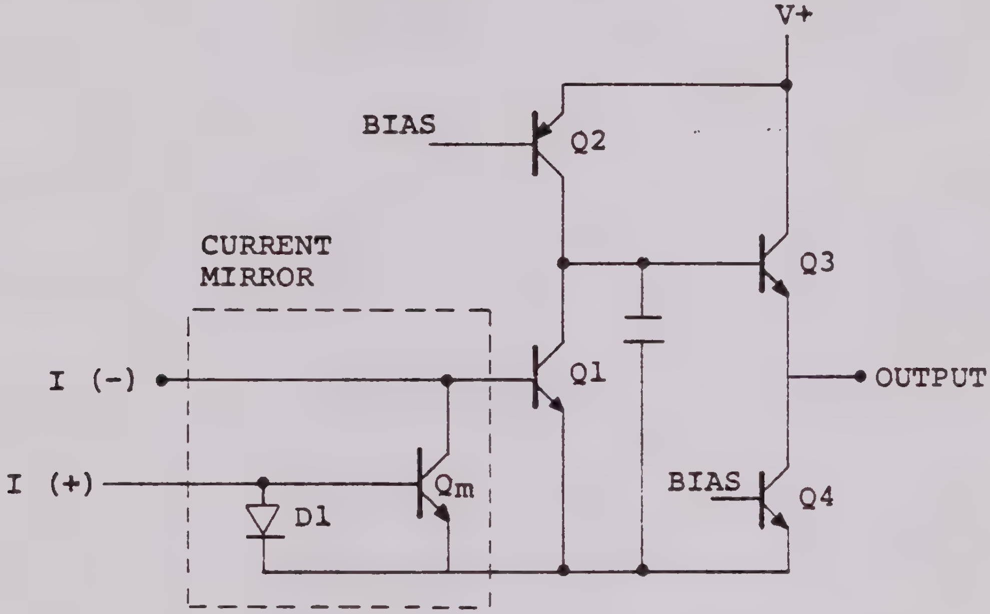
a. Filament Time Delay Timer
b. High Voltage Control
c. Fault Detection
d. Local Status Displays
e. Remote Control and Indicator Interface
f. AC Prime Power Control
g. Local/Remote Operation Mode Selection

Refer to the Fault Logic and Timer schematic (Section 6) for the following discussions.

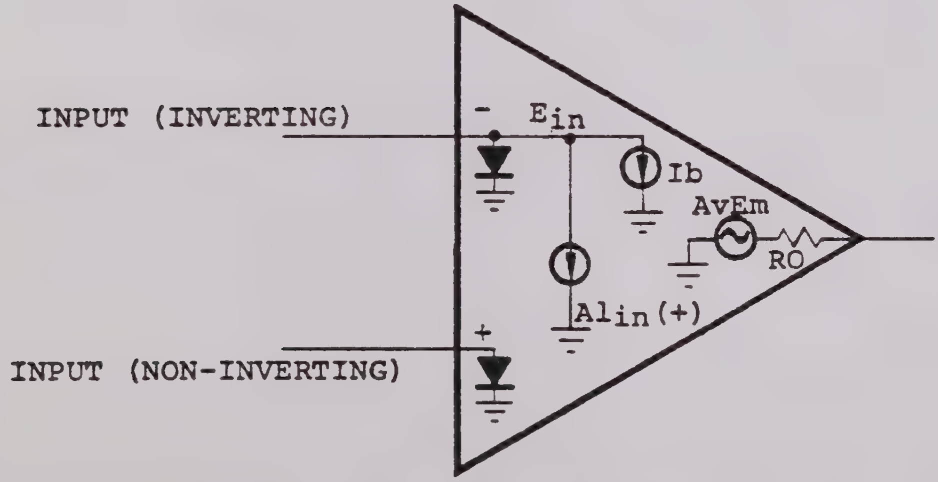
4.3.3.1 Basic Circuit Element. The design of the logic circuits is based on the use of a current differencing amplifier (CDA). The symbol for a CDA is shown in Figure 4-13a. A simplified schematic and equivalent circuit are also shown in Figure 4-13a. The current mirror portion of the circuit (Figure 4-13b) is such that current on the plus side (non-inverting input) acts as a



a) ENGINEERING DRAWING SYMBOL


V+
BIAS
Q2
CURRENT
MIRROR
Q3
I (-)
Q1
OUTPUT
I (+)
Qm
D1
BIAS
Q4

b) SIMPLIFIED SCHEMATIC


INPUT (INVERTING)
-
Ein
Ib
AvEm
RO
AIin(+)
+
INPUT (NON-INVERTING)

c) SIMPLIFIED EQUIVELENT CIRCUIT

FIGURE 4-13 CURRENT DIFFERENCING AMPLIFIER (CDA)

current source at the minus (inverting input). The CDA operates in such a manner that the minus side current equals the plus side current. As a result the voltages at the two inputs of the CDA are essentially constant. This is different from the conventional OP amps used as comparators where changing voltages are compared. In the case of the CDA when the input current varies (rather than the input voltages) the CDA output changes state.

In Figure 4-13(c) the minus (-) input is designated as an inverting input while the plus (+) input is designated as the non-inverting input.

An increase of the current in the plus (+) input (logic high) causes the output of the CDA to go high if the circuit is designed to normally operate with I(+) less than I (-) and set the output low. In this case, an increase in the magnitude of I (-) does not cause the output to shift. However, if the value of I (-) is decreased to the point where I (-) is less than I (+), the output of the CDA would go high (i.e. the input on I (-) line is inverted). Consequently, the CDA can be set up for a reference on either leg depending on whether one wants an inversion of the incoming signal or not.

Resistors in series with the two input lines are used to establish the magnitude of current in each input and to set the threshold for logical output shifts.

The LM 3900, which is the CDA used in the TWTA, consists of four independent, dual input, internally compensated amplifiers which operate off a single power supply and provide a relatively large output voltage swing.

Consider U6A of the Logic schematic as shown in Figure 4-14 which is used to monitor the interlock switches. When the normally open cover interlock switch is in the normal operation position, it is held closed by the top cover. This shorts the junction of the 100K resistors controlling the (+) input to the logic supply return. As a result, the input current in the U6A minus leg through the 300K resistor (R7) is greater than that in the plus leg (essentially zero). When the top cover is removed, the interlock switch opens and allows the (+) leg of U6A to draw more current than the minus leg, I(+) = 1.5 I(-). U6A attempts to drive the current in the minus leg to match that in the plus leg so that the differential current is nearly zero and as a result the output of U6A changes from a logical low to a logical high. The output of U6A is used to drive the summary fault detector (U1C) and to drive local and remote indicator drive circuits.

4.3.3.2 Filament Time Delay Timer (FTD) The FTD circuits include a Timer (U3A), a clock and a status detector. The nominal time delay is 3 minutes which allows the TWT Filament sufficient time to heat up and stabilize. When AC power is applied, 12 VDC is impressed on R11 which controls the current to the (+) input of U3A. At this point I(+) is higher than I(-) and the output of U3A drives positive until the current in IC-7 is equal to I(+). Since C7 is discharged at the time power is applied, I(-) is essentially zero. U3A drives enough current through C7 to keep I(-) equal to I(+). It is in essence a constant current source charging C7. The output of U3A if viewed with respect to time is a ramp During the charging cycle the current in the (+) leg of U3B is less than that in the (-) leg of U3B. The (-) current input to U3B is controlled by variable resistor R14. At a certain point, the current applied to the (+) leg of U3B exceeds that in the minus leg and the output (U3B-5) goes high signifying that the time delay period is over. Adjustment of R14 so that I(-) is lower would result in shorter time delays and vice-a-versa.

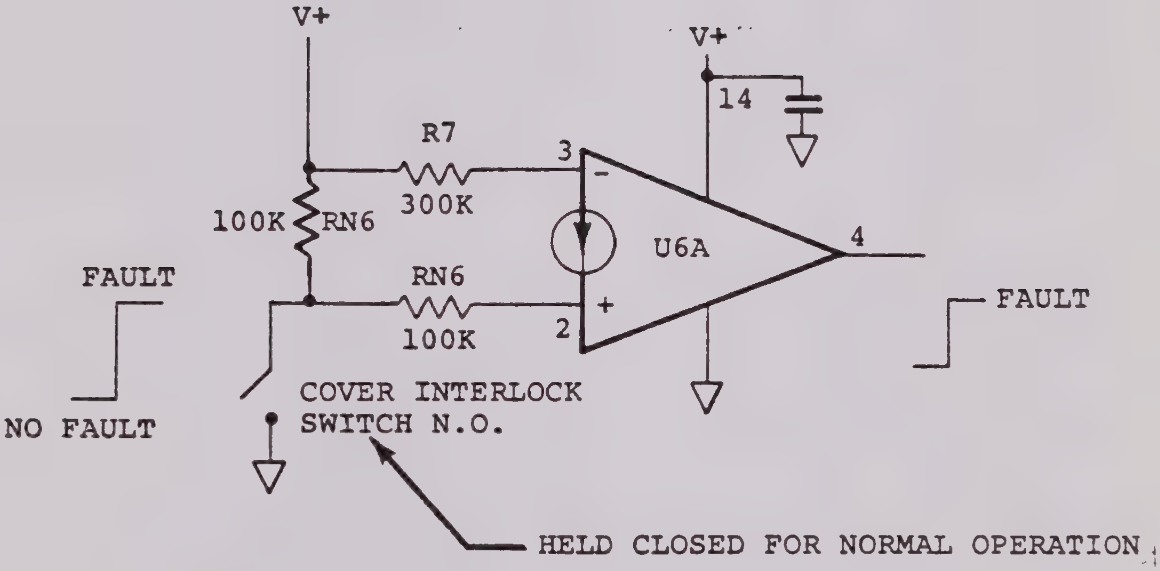

V+
V+
14
R7
300K
3
100K
RN6
U6A
4
FAULT
RN6
100K
2
FAULT
NO FAULT
COVER INTERLOCK
SWITCH N.O.
HELD CLOSED FOR NORMAL OPERATION

FIGURE 4-14 INTERLOCK CIRCUIT MONITOR LOGIC U6A

When the output of U3B goes high this drives the current on the sensing input of U1D high which drives the U1D output high and signals the rest of the logic (via CR6 and U1B) that FTD is complete.

Note that all the time prime power is on, the current controlled by R11 is a constant value. If prime power is interrupted, I(+) to U3A falls to a value less than I(-) and the output of U3A goes low. When this happens C7 discharges through U10 at a rate equal to 2 X the charging rate. Therefore, if power is interrupted for 20 seconds and then restored, the FTD circuits will indicate FTD in progress for the 40 seconds it takes to recharge C7. For a 3 minute cycle, outages of less than 90 seconds will result in proportional delays and as the full 3 minutes for outages greater than 90 seconds.

4.3.3.3 High Voltage Control The HV ON/OFF control signal from the logic to the TWTA supplies is brought out on the output of U4 pin 4. U4, which is a multi-transistor chip is set up so that the transistors act as switches. When these transistors are on, the collector is pulled high (to 12 VDC minus the drop in the transistors), and used as a control signal or to drive an associated indicator. U4-4 actuates the HV ON/OFF control and indicator U8/16. The signal on U4-6 is controlled by the output of U1B (pin 5). U1B-5 also controls U1A which controls the standby indication. U1A is also connected to the FTD status detector U1D via R13.

U1B is established so that the sensing line I(-) signal is inverted, i.e. when the current to U1B-6 goes high, U1B-5 goes low.

NOTE

> Where the sensing lines go to the I(+) input, a fault is indicated by the line going high and the CDA output going high. When the sensing lines go to the I(-) input, a low on the line indicates a fault and the CDA output goes high.

Each CDA has input resistors to establish the no-fault/fault currents. The resistors coupling the outputs to the inputs for the non-inverting circuits are used to provide the proper operating characteristics.

Diodes CR2, CR3, CR4 and CR5 form an OR circuit that is connected to the inverting sense line of Summary Fault detector U1C. (U1C-8) If any one of the fault detectors go high, the output of U1C is driven low.

U1B-6 senses the output of U1D-10 via CR6 and the output of U3D-10 via R10, RN5 (12,3). U3D is also established with an inverting sense line (U3D-11) that is normally high (HV OFF) and pulled low (HV ON) via S1 in the local mode or via an external command in the remote mode (if the TWTA incorporates the remote option). Jumper 3 is installed when the TWTA does not include the Remote Control option.

4.3.3.4 Fault Detection Logic. U6C, U6D, U6A and U3C are the CDAs used for the detection of individual faults as follows:

FAULT	DETECTOR CDA
Helix Current Overcurrent	U6C
Low Line Voltage	U6D
Interlock Open	U6A
TWT Overtemperature	U3C

4.3.4 High Voltage Assembly (A1)

NOTE

In the following discussion of the High Voltage Assembly, all reference designations are preceded by A1, e.g. the correct designation for R1 is 1A1R1.

The High Voltage Assembly provides the filament (heater) supply and the high voltage supplies.

4.3.4.1 Filament Supply. The purpose of this circuit is to provide a low voltage regulated bus of 6-7 VDC that can operate in conjunction with a high voltage supply. 115 VAC is routed to J5-1, J5-2 from the prime power interface circuits. The AC supply voltage is then distributed within the High Voltage Assembly to J3-12, J3-13 and J4-2, J4-3. Heater transformer T3 is connected to J3-12, J3-13. The secondary of T3 is routed to J3-1, 2, and 3 with J3-1 being connected to the center tap of the secondary of T3. The 18 VAC output of T3 is rectified by CR1, CR2, filtered by C1, C9 and connected to regulator U1. Variable resistor R1 is used to adjust the output to the value (6-7 VDC) desired. Diode CR3 provides protection against transients which might be induced by TWT arcs. Capacitor C2 filters the output of U1. Zener VR1 limits the maximum output of U10 to 7.5 VDC.

4.3.4.2 High Voltage Supplies. This set of circuits provide the high voltages for the TWT helix and collector. The helix voltage is determined by the collector and cathode supplies. The output of the Power Processor PCB Assembly is a regulated 60-115 V 20 KHz bus which is applied to the primary of high voltage transformer T2.

One secondary of T2 (34, 32, 30) is equipped with multiple taps (see schematic) to provide different ratios of HV between cathode to collector and cathode to helix. The selected output is applied to a full wave high voltage rectifier consisting of CR8, CR9, CR10 and CR11. The output of this bridge is filtered by C6.

The other secondary (24, 27) provides the cathode to collector voltage. This voltage is applied to a full wave bridge consisting of high voltage diodes CR4, 5, 6 and 7. The output of this bridge is filtered by C3. Resistors R4, R5, R6 and R7 are used to limit

the secondary currents of transformer T2. The collector voltage is filtered by L1 and C5. A spark gap is connected across Choke L1.

The filtered HV outputs across C3 and C6 are added together to provide the cathode to helix voltage whose magnitude is controlled by 1A2R33 on the Power Processor PCB Assembly.

The cathode voltage is sensed via R19 and fed to the feedback amplifier of the Power Processor PCB. CR12 clamps this feedback point to near ground potential. R19 is in series with two resistors on the Power Processor PCB Assembly, 1A2R18 and 1A2R19. (See Section 3.3.2.5 for a discussion of HV Feedback).

4.3.5 Grid PCB Supply (A5)

NOTE

> In the following discussion of the Grid PCB Supply, all reference designations are preceded by A5 e.g., the correct designation for R1 is A5R1.

The Grid Supply is only used with certain tubes and provides regulated positive or negative (with respect to the cathode) voltage as required. 18 VAC supplied from the High Voltage Assembly is applied (at J1-12, J1-13) to transformer T1. The secondary of T1 is connected to full wave rectifier bridge CP1 and then filtered by C1. One side of the bridge output is connected to the helix via R11 and R14., The voltage across C1 is impressed on a resistor string consisting of R16, R2 and R1. The voltage across R16 is brought out to the grid and collector through Q2 which controls the magnitude of the voltage. This voltage is selected via variable resistor R7.

4.3.6 Anode Supply (A6)

NOTE

> In the following discussion of the Anode Supply, all reference designations are preceded by A6, e.g., the correct designation for R1 is A6R1.

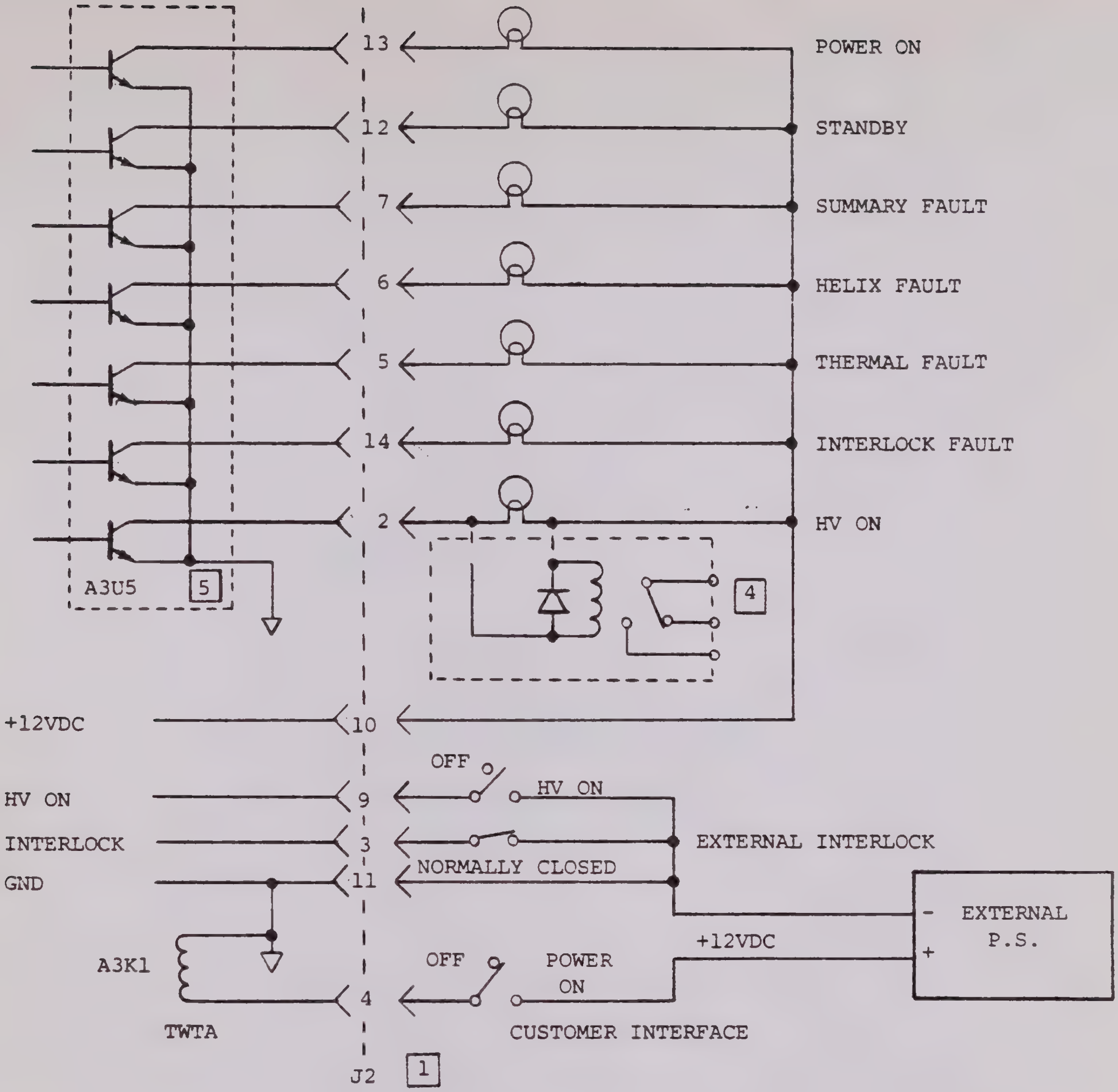
The Anode Supply is a simple adjustable DC supply. 115 VAC routed via the High Voltage Assembly is applied to transformer T1 via pins J1-2, J1-3. The secondary output is rectified by full wave bridge CR1 and filtered by C1 to develop a supply voltage of about 480 VDC. The combination of Q1 and Q2 is used to set the current through R1, R2 to establish the desired output voltage. This voltage is adjustable via variable resistor R3 from 0 to 300 VDC. Capacitor C2 provides additional filtering and R6 limits the current that can be drawn by the anode.

4.3.7 Remote Control Interface Option

Refer to the Logic Schematic. Indicator outputs that duplicate and supplement the Front Panel displays are provided by A3U5, a multi-transistor chip. These outputs are referenced to the TWTA chassis ground. In addition a +12 VDC bus is provided to power external indications. The other interfaces provided are an external interlock circuit that can be connected in series with the TWTA interlock circuit and command inputs for Prime Power ON, HV ON/OFF, and Remote/Local operations. The operation of these interfaces is readily determined by inspection of the schematic in conjunction with the earlier discussion of the Logic functions in Sections 4.3.3 and 3.3.3. External +12 VDC (reference to chassis ground) should be connected to remote interface pin 4 to operate remote prime power on function. Refer to Figure 4-15.

4.4 DETAILED DISCUSSION OF RF SECTION

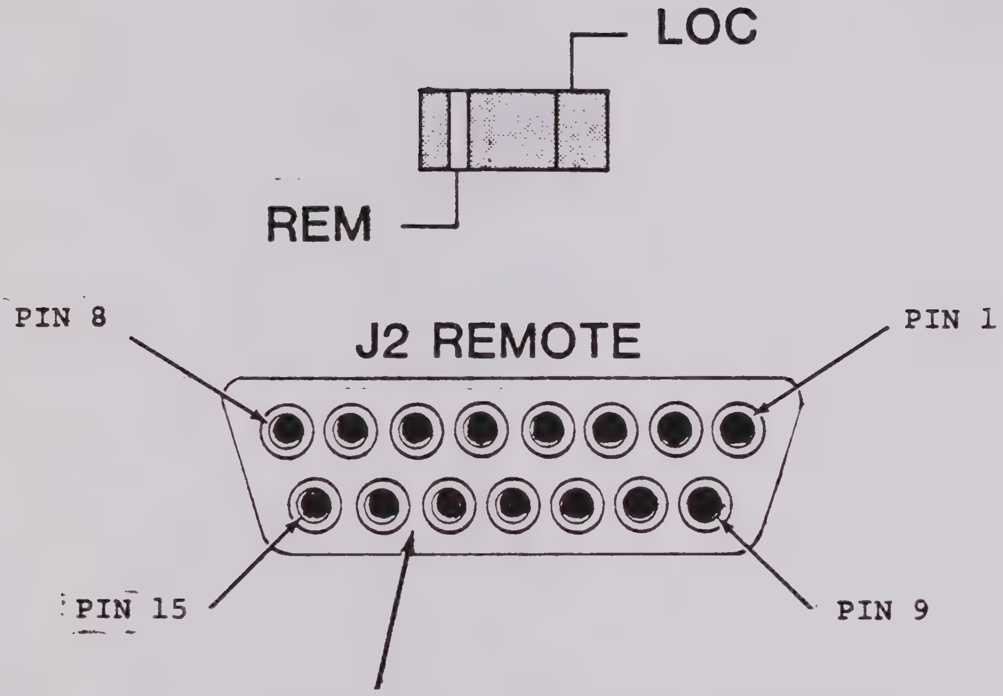
A functional block diagram of the RF Section including all the standard options is presented in Figure 4-16. The "K-Series"


POWER ON
STANDBY
SUMMARY FAULT
HELIX FAULT
THERMAL FAULT
INTERLOCK FAULT
HV ON
13
12
7
6
5
14
2
A3U5
5
4
+12VDC
10
HV ON
9
INTERLOCK
3
GND
11
A3K1
4
TWTA
J2
1
OFF
HV ON
EXTERNAL INTERLOCK
NORMALLY CLOSED
EXTERNAL P.S.
-
+
+12VDC
OFF
POWER ON
CUSTOMER INTERFACE

NOTES:

1. J2 IS LOCATED ON THE REAR PANEL.
2. LOCAL/REMOTE SWITCH ON THE REAR PANEL MUST BE IN REMOTE POSITION TO ENABLE CONTROL OF REMOTE POWER ON AND REMOTE HV ON.
3. IF EXTERNAL INTERLOCK SWITCH NOT USED, CONNECT A JUMPER BETWEEN J2-3 AND J2-11.
4. STATUS OUTPUTS MAY BE USED TO OPERATE RELAY COILS. DISCHARGE DIODES MUST BE CONNECTED ACROSS COILS IN THIS CASE.
5. A3U5 IS ULM2081A (SPRAGUE). IT'S MAXIMUM RATING IS: COLLECTOR TO EMITTER VOLTAGE, 14 VDC AND CURRENT 30 mADC.

FIGURE 4-15 TYPICAL REMOTE CONTROL INTERFACE


LOC
REM
PIN 8
J2 REMOTE
PIN 1
PIN 15
PIN 9

15 PIN CONNECTOR : T&B ANSLEY #609-155

FIGURE 4-15-(1) REMOTE INTERFACE CONNECTOR AND SWITCH

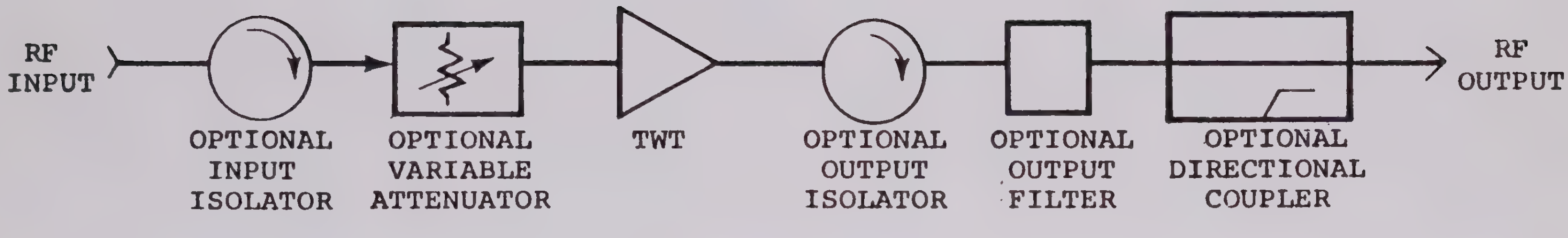

RF INPUT
OPTIONAL INPUT ISOLATOR
OPTIONAL VARIABLE ATTENUATOR
TWT
OPTIONAL OUTPUT ISOLATOR
OPTIONAL OUTPUT FILTER
OPTIONAL DIRECTIONAL COUPLER
RF OUTPUT

FIGURE 4-16 RF SCHEMATIC

amplifiers covers a relatively wide range of frequencies. The specific tube types available are summarized in Table 1-1.

4.4.1 Optional Input Isolator

The optional Input Isolator provides isolation between the input source and the TWT. Typical input VSWR is 1.5:1.

4.4.2 Optional RF Attennuator

The Optional variable RF Attenuator control provides a zero to 20 dB continuous variation in RF gain of the TWTA. This is connected between the RF input port and the TWT input and may be used to set the level of the RF output power.

4.4.3 Optional Harmonic Filter

The Optional Harmonic Filter reduces carrier harmonic outputs from the TWT to typically 60 dB below the carrier. It is installed in the output circuit between the TWT and RF output.

4.4.4 Optional RF Output Sample Port

When this option is installed, the RF output passes through the RF directional coupler. Here a -30 dB sample is taken and cabled to the front panel RF sample port. This permits accurate power monitoring of the output power on the TWTA.

4.4.5 Optional Output Isolator

The optional Output Isolator isolates the TWT output from the TWTA load. This results in improved performance of gain variation vs frequency and protection for the TWT. The isolator integral load is capable of dissipating full reflected power from the TWTA load.

SECTION 5

MAINTENANCE

5.1 GENERAL

This section discusses preventive maintenance, RF output power checks, adjustment and calibration, troubleshooting procedures, and removal/replacement procedures.

In the event that repair and/or modification to this amplifier is not performed by Varian or under Varian's direction, the warranty of the unit may be voided at Varian's sole discretion. See warranty information included at the rear of this manual.

If the system is not operating properly, and you cannot or do not intend to service it yourself, contact your nearest Varian field office for assistance.

****

WARNING

****

LETHAL VOLTAGES UP TO 5 KV ARE PRESENT WHEN POWER IS APPLIED TO THE SYSTEM. BE EXTREMELY CAREFUL WHEN WORKING INSIDE THE UNIT. USE ONLY ONE HAND TO MAKE MEASUREMENTS OR ADJUSTMENTS. IF POSSIBLE TURN POWER OFF BEFORE MAKING ADJUSTMENTS. DO NOT ATTEMPT TO REPAIR OR TROUBLESHOOT THIS UNIT UNLESS YOU HAVE HAD EXPERIENCE IN SERVICING BOTH MICROWAVE AND HIGH VOLTAGE SYSTEMS AND HAVE READ THE GUIDELINES IN THE SUPPLEMENTARY DATA SECTION OF THIS MANUAL PERTAINING TO HIGH VOLTAGE AND MICROWAVE RADIATION.

****

Prior to applying power to the unit, verify that a suitable RF load, adequate to handle up to twice rated power without damage, and with a maximum VSWR of 1.5:1 across the power amplifier operating range, is provided at all times. Operation of the system without a suitable load can damage or destroy the TWT.

CAUTION

Be sure to terminate the RF input and output before applying prime power.

5.2 TEST EQUIPMENT REQUIRED

Table 5-1 is a list of test equipment required in order to perform the maintenance routines described in subsequent sections. Equipment with equivalent accuracy or capacity may be substituted.

5.3 PREVENTIVE MAINTENANCE

Preventive maintenance includes periodic visual inspection, routine cleaning, and those regularly scheduled service.

As a major aid to maintenance, it is recommended that an operations log be maintained for the equipment. This log should be used to record all meter readings daily and should note all preventive and corrective maintenance operations. Experience has shown that analysis of long term changes in operational conditions is of great value in predicting potential failures, and in quickly analyzing the cause of failures.

TABLE 5-1

TEST EQUIPMENT REQUIRED

DESCRIPTION	MANUFACTURER	MODEL
Sweep Signal Generator	Systron Donner/Kruse	540 with correct plug in for frequency range.
Coaxial Termination	Narda	369BNM/NF
Waveguide Termination	Waveline	781
Directional Coupler	Narda	3040-3045 Series
	Hewlett-Packard	P752 series 10 dB & 30 dB
Power Meter	General Microwave	460B
Frequency Meter	Nytek	9011-A
Variable Attenuator	Merrimac	AU15A
	Hewlett-Packard	P382A
DVM	Data Precision	248
Volt-Ohm-Milliammeter	Triplett	630
Oscilloscope	Tektronix	475
Differential Voltmeter	Fluke	895A
H.V. Divider	Fluke	80 F-15
Clip-On Milliammeter	Hewlett-Packard	412A
Power Supply	Hewlett-Packard	723A

5.3.1 Visual Inspection

At periodic intervals, the TWTA should be inspected to permit early detection of wear or damage which, if properly corrected, will prevent equipment malfunction or failure. Inspections should include, but not be limited to, visual checks for wear, breaks, deterioration, fungus, excess moisture, mounting integrity, and other similar defects. In a normal environment, inspection should be made at 90-day intervals. If the equipment is subject to severe environmental conditions, such as dusty input ambient air, temperature extremes, or excessive shock or vibration, inspections should be performed on a weekly or monthly basis. Visual inspection items are listed in Table 5-2.

5.3.2 Routine Cleaning

The necessary materials and outline procedures for cleaning the TWTA are listed in Table 5-3.

****

WARNING

****

TURN ALL POWER OFF BEFORE ATTEMPTING ANY CLEANING OPERATION. WHEN USING SOLVENTS BE SURE TO PROVIDE ADEQUATE VENTILATION AND AVOID BREATHING THE FUMES. WHEN CLEANING WITH AIR, WEAR SAFETY GOGGLES AND USE CLEAN, DRY, COMPRESSED AIR, NOT EXCEEDING 25 PSI.

****

TABLE 5-2

VISUAL INSPECTION ITEMS

ITEM	POTENTIAL FAULT	CORRECTIVE PPOCEDURE
Connector Plugs	Damaged or improperly seated in mating connectors	Replace connector plugs, properly seat replacement plug
Electrical Wiring	Broken, burned or pinched	Repair or replace defective wires
Soldering Connection	Corroded, cracked or dirty	Clean and resolder connections
Dirt or Moisture Buildup	Short circuits, arcing, corrosion	Cleaning (See Table 5-3)
Chassis Slides	Slides damaged or not sliding freely	Cleaning (See Table 5-3)

TABLE 5-3

ROUTINE CLEANING PROCEDURE

ITEM	PROCEDURE
Chassis	Clean with lint-free cloth, small vacuum or low pressure compressed air.
Wire Bundles and Wiring	Clean with a soft-bristle brush, small vacuum or compressed air.
Connector Jacks and Plugs	Remove dust and dirt with soft-bristle brush or lint-free cloth.
Circuit Boards	Clean with dry, soft-bristle brush, small vacuum or low-pressure compressed air.
Solder Connections	Remove dirt, oil and/or excess flux with isopropyl alcohol. Remove corrosion by lightly burnishing with crocus cloth and clean with a lint-free cloth.
Waveguide Assemblies, Clamps, Cables and Rubberized or Plastic Parts	Clean with a lint-free cloth moistened with warm soap and water solution; wipe with clean water and dry. Use low-pressure air if available.
Chassis Slides	Clean with Isopropyl Alcohol. Lubricate with Lubriplate No. 110 or equivalent.

5.3.3 Lubrication

The optional chassis slides lubrication is recommended annually. Clean the slide mechanism with an approved solvent such as Isopropyl Alcohol. Lubricate the slides with a small stiff-bristled brush and a light coat of Lubriplate No. 110 (or equivalent). Wipe off excess lubricant with a clean lint-free cloth. No other lubrication is required for the TWTA.

5.3.4 Paint Touch-Up

Most finish repairs consist of retouching minor marred or scratched surfaces. A camel's hair brush lightly dipped in a suitable enamel or 26440 gray, Fed-Std-595 will accomplish the touchup desired. Deep scratches, chips, or gouges should first be smoothed or removed by a light sanding with fine (No. 00 or 000) sandpaper and then the surface painted as required to restore the finish.

5.4 RF OUTPUT POWER CHECK

Refer to Table 5-1 for test equipment required. Equipment with equivalent accuracies or capacities may be substituted for testing purposes. Be sure to select equipment that operates in the proper frequency band.

NOTE

> This check may be performed at any frequency within the range of your specific TWTA.

a. Turn AC power OFF.

b. Set up a microwave measurement circuit, such as the one shown in Figure 5-1.

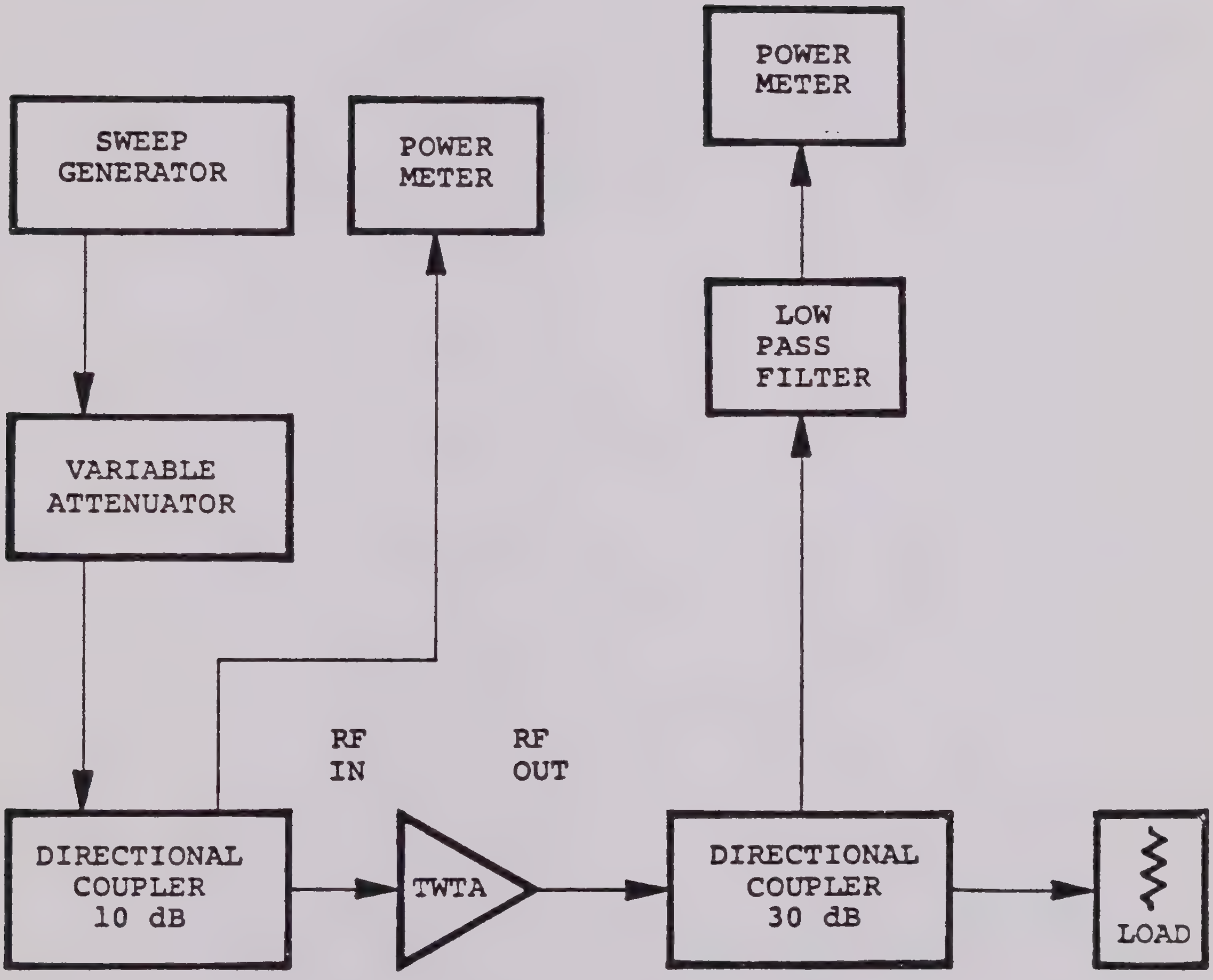

SWEEP GENERATOR
POWER METER
POWER METER
LOW PASS FILTER
VARIABLE ATTENUATOR
RF IN
RF OUT
DIRECTIONAL COUPLER 10 dB
TWTA
DIRECTIONAL COUPLER 30 dB
LOAD

FIGURE 5-1 MICROWAVE MEASUREMENTS CIRCUIT

NOTE

If the optional RF Gain Control is installed, turn the GAIN control fully clockwise.

c. Set the output of the microwave signal source to the minimum value.

d. Calculate the limits on RF input microwave power needed to produce the output power specified on the data sheet, taking into account the specified gain. (The actual input power applied to the unit should never be more than 3 dB greater than the calculated value).

e. Turn AC power ON.

f. Test for gain as follows:

    1. Adjust the input microwave power so that the TWTA operates at rated output power.

    2. Measure the input microwave power.

    3. Calculate the gain. This should match or exceed the gain specified on the TWTA data sheet.

g. Determine saturated output power by adjusting the input power to peak output power. This value should meet or exceed the minimum power level specified on the TWTA data sheet.

h. This completes the RF Output Power Check.

5.5 ADJUSTMENT AND CALIBRATION

Adjustment and calibration of the Power Amplifier is required when either TWT or a major assembly is replaced or after repairs have been made. No adjustment procedure should be attempted until:

a The Theory of Operation Section of this manual is read and the function of the circuits and circuit adjustments are fully understood.

b The guidelines in the Supplementary Data Portion of this manual on High Voltage and Microwave Radiation are fully understood.

****

WARNING

****

LETHAL VOLTAGES UP TO 5 KV ARE PRESENT IN THE POWER AMPLIFIER WHEN IT IS OPERATING. USE EXTREME CAUTION WHEN WORKING INSIDE THE UNIT. AS AN ADDED PRECAUTION, IT IS RECOMMENDED THAT ANOTHER PERSON BE PRESENT TO GIVE AID IN CASE OF ACCIDENT.

****

The unit is designed so that it does not require many adjustments or calibrations. Excluding the optional RF Gain Control, the adjustments are limited to potentiometers on the Power Processor PCB Assembly (A2), the High Voltage Assembly (A1) or the Logic Board (A3). Some internal jumpers are used at the time of equipment manufacturer and normally do not require adjustment in the field.

In the Adjustment/Calibration discussions (Section 5.5), the Troubleshooting Procedures (Section 5.6) and the Removal and

Replacement Procedures (Section 5.7), there are frequent references to the need to turn prime power or tube high voltage on and off. Prime power can be controlled from the Front Panel of the unit by depressing the PWR ON/OFF switch in the direction of the desired action. The PWR ON/OFF switch is in the OFF position when the bottom half of the switch is flush with the panel and in the ON position when the top half is flush with the panel. The same is true for the High Voltage (HV) switch. In the procedures, the instruction "turn AC power on" means depress the PWR ON/OFF switch so that the upper half of the switch rocker is flush with the panel. The same short hand notation is used for turning AC power off and high voltage on or off.

CAUTION

This amplifier uses an off-line regulator to develop the voltages used to operate the TWT. Extra precautions are necessary before the amplifier is serviced. It is suggested that an isolation transformer be used to provide AC power to the amplifier before servicing the unit.

5.5.1 Power Processor Assembly Adjustments (See Figure 5-2)

a. Switch Regulator Adjustment (1A2R33).

1. Turn power switch OFF and wait 30 seconds.
2. Connect DVM across C26.
3. Turn on AC PWR switch ON and HV Control Switch OFF.
4. Adjust R33 CW until SUM FAULT LED lights at a nominal 120 VDC. Adjust R33 CCW until SUM FAULT light goes out.
5. Adjust R33 for 115 VDC. Adjustment complete.

b. High Voltage Adjustment (1A2R19)

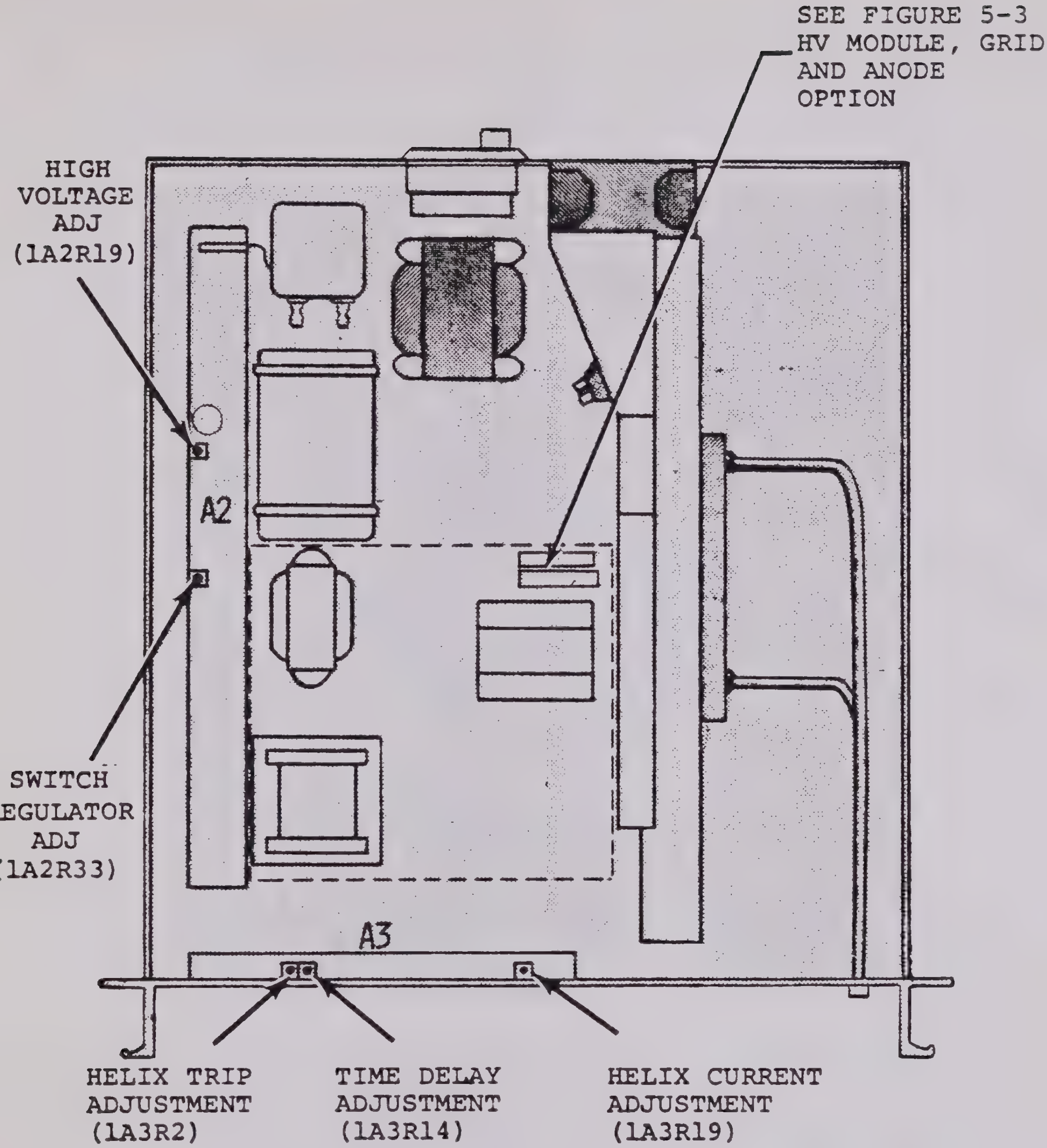

SEE FIGURE 5-3
HV MODULE, GRID
AND ANODE
OPTION
HIGH
VOLTAGE
ADJ
(1A2R19)
A2
SWITCH
EGULATOR
ADJ
1A2R33)
A3
HELIX TRIP
ADJUSTMENT
(1A3R2)
TIME DELAY
ADJUSTMENT
(1A3R14)
HELIX CURRENT
ADJUSTMENT
(1A3R19)

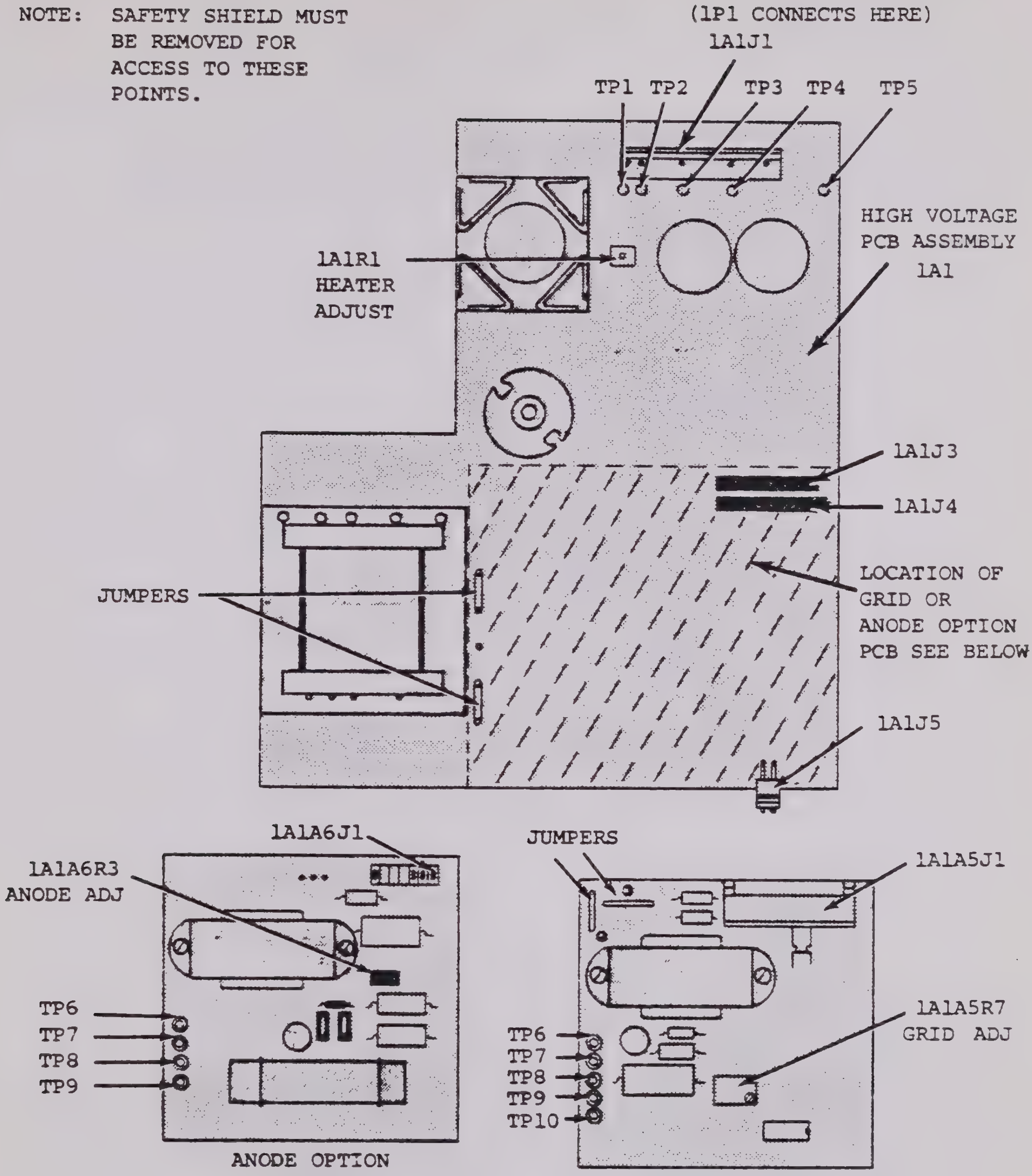
FIGURE 5-2 TWTA TOP VIEW

NOTE

Use a Fluke 80F-15 HV Divider or equivalent for procedures requiring high voltage measurement. Due to the potential High Voltage hazards to personnel, Varian recommends the use of a proven commercial design rather than homemade substitutes.

Proceed as follows: (See Figure 5-3)

1. Turn off AC power. Wait 30 seconds and short 1A1TP1 to chassis.
2. Connect H.V. Divider from 1A1TP1 (high potential lead) to A1TP5 (Gnd lead) and DVM.
3. Check jumper Table 5-4. Refer to the TWT name plate and determine the voltages required for the collector to cathode and cathode to helix. Make sure the jumpers are installed properly according to Table 5-4.
4. Remove TWT connector 1P1 from 1A1J1 and the shorting lead on 1A1TP1.
5. Turn on AC power.
6. Wait three minutes until heater time delay is complete.
7. Turn on High Voltage.
8. Adjust 1A2R19 until the voltage required on the TWT cathode to helix as measured by the DVM connected to the HV Divider is correct (record this voltage in TWTA log book).
9. Turn off H.V. and AC power and wait 30 seconds. Short 1A1TP1 to chassis.
10. Connect H.V. Divider from 1A1TP5 (ground lead) to 1A1TP3 (high potential lead) and DVM.
11. Remove shorting lead from 1A1TP1.
12. Turn on AC power and wait 3 minutes.
13. Turn on H.V. control.


NOTE: SAFETY SHIELD MUST BE REMOVED FOR ACCESS TO THESE POINTS.

(1P1 CONNECTS HERE)
1A1J1
TP1
TP2
TP3
TP4
TP5
HIGH VOLTAGE PCB ASSEMBLY 1A1
1A1R1 HEATER ADJUST
1A1J3
1A1J4
LOCATION OF GRID OR ANODE OPTION PCB SEE BELOW
JUMPERS
1A1J5
1A1A6J1
1A1A6R3 ANODE ADJ
TP6
TP7
TP8
TP9
JUMPERS
1A1A5J1
1A1A5R7 GRID ADJ
TP6
TP7
TP8
TP9
TP10

ANODE OPTION PCB ASSEMBLY 1A1A5

GRID OPTION PCB ASSEMBLY 1A1A6

FIGURE 5-3 HIGH VOLTAGE ASSEMBLY TEST POINTS & ADJUSTMENTS

TABLE 5-4

JUMPER TABLE

TWT TYPE	HELIX VOLTAGE ADJUSTMENT RANGE	COLL VOLTAGE	JUMPERS LOCATED ON HV PCB	
			JUMPER	JUMPER
VTL-6140B1 VTS-6150B1 VTS-6150J1	1.2-2.1 kV Helix	Equal to	None	None
VTS-6055A1 VTH-6079H1 VTC-6166J1	1.6-2.8 kV	75% of Helix	1 to 4	2 to 5
VTX-6089H3	2.0-3.6 kV	60% of Helix	1 to 3	2 to 4
VTX-6186B1 VTM-6196B1 VTU-6196B2	2.4-4.3 kV	50% of Helix	1 to 3	2 to 5

NOTE: Helix and collector voltages are referenced to TWT Cathode.

14. Read collector to helix volts on DVM connected to the HV Divider.

15. Calculate collector to cathode voltage as follows:. subtract collector to helix voltage reading (step 14) from cathode to helix volts (step 8).

NOTE

> The collector voltage is a fixed percentage of the helix to cathode voltage. The percentage valued are selected by jumpers located in the HV Module. Refer to Table 5-4 for required jumper positions for various TWTs.

16. Turn off HV. Turn OFF AC power. Wait 30 seconds and short 1A1TP1 to chassis.

17. Install TWT connector 1P1 on 1A1J1.

18. Remove shorting lead from 1A1TP1.

19. Repeat steps 5 thru 16.

20. Remove test equipment.

5.5.2 High Voltage Assembly Adjustments. (See Figure 5-3)

a. Heater Voltage Adjustment.

1. Turn off AC power and wait 30 seconds.
2. Short 1A1TP1 to chassis.
3. Turn off H.V. control. Remove short from 1A1TP1 to chassis.
4. Open interlock Switch S1.
5. Connect DVM from 1A1TP1 (+) to 1A1TP2 (-).
6. Turn on AC power.
7. Wait three minutes. Adjust 1A1R1 to read 6.3 volts ± .2 VDC.
8. Turn off AC power.
9. Remove DVM.

5.5.3 Optional Anode Adjustment (See Figure 5-3)

a. Turn off AC power.

b. Short 1A1TP1 to chassis.

c. Remove short from 1A1TP1 to chassis.

d. Connect DVM from 1A1TP5(-) to 1A1TP-4 (+).

e. Turn off H.V. switch.

f. Open interlock SW S1.

g. Turn on AC power.

h. Refer to TWT nameplate or TWTA data sheet for proper anode voltage value.

i. Adjust 1A1A6R3 to read the voltage required for the TWT.

j. Turn off AC power.

k. Remove DVM.

5.5.4 Optional Grid PCB Assembly Adjustment

****

WARNING

****

GRID ADJUSTMENTS MUST BE PERFORMED WITH H.V. OFF. IF H.V. IS ON, THIS WOULD FORCE THE DVM AND THE ADJUSTMENT POTENTIOMETERS TO BE AT CATHODE (H.V.) POTENTIAL. THE FOLLOWING ADJUSTMENTS ARE MADE WITHOUT TURNING ON THE HIGH VOLTAGE.

a. Turn off AC power and wait 30 seconds.

b. Short 1A1TP1 to chassis.

c. Remove short from 1A1TP1 to chassis.

d. Connect DVM from 1A1TP1(-) to 1A1TP4(+).

e. Turn off high voltage.

f. Open interlock switch S1.

g. Check TWT grid voltage requirement by referring to TWT nameplate on TWT data sheet.

h. Negative adjustment.

   1. For negative grid operation refer to Table 5-5 and verify that jumpers 1 to 2 and 4 to 5 are installed properly. (See Figure 5-3)
   2. Turn on AC power.
   3. Adjust 1A1A5R7 to read voltage required by the TWT grid as read on DVM.
   4. Turn off AC power and wait 30 seconds.
   5. Remove DVM.

i. Positive grid adjustment.

NOTE

The measurement of the positive grid voltage involves a safety approach in which the output is set up as a negative grid and the grid voltage is adjusted to read the voltage needed by the tube plus .7 volts. Once the voltage is set, the jumpers 2, 3, 5 and 6 are selected to make it a positive grid configuration

1. Set up as indicated in para. 5.5.4 steps a through h. (This starts out as negative grid adjustment).
2. Open interlock switch and turn off high voltage switch.
3. Turn on AC power. Refer to voltage required for the positive grid TWT by looking at the TWT nameplate or the TWTA Data Sheet.
4. Adjust 1A1A5R7 to read the voltage required plus .7 VDC. For example, if the required voltage is +14 volts, set the voltage measured to -14.7 VDC.
5. Turn off AC power, wait 30 seconds.
6. Remove DVM.
7. Change jumpers from negative grid to positive grid operation. Refer to Table 5-5. Install jumpers 3 to 2 and 5 to 6.

NOTE

If the correct voltage is setup in step 4 and the jumpers are not changed as indicated in step 7, the TWT will not turn on.

5.5.5 Three Minute Time Delay Adjustment

NOTE

This is normally a factory adjustment that does not require further field adjustment.

TABLE 5-5

GRID SUPPLY JUMPERS

	JUMPER ASSIGNMENT	
POSITIVE GRID	3-2	5-6
NEGATIVE GRID	1-2	4-5

a. Turn off AC power. Wait 3 minutes.

b. Connect DVM from 1A3TP1(-) to 1A3T5(+).

c. Turn on AC power switch and note time ON.

d. After 3 minutes "exactly", read DVM and record this voltage. (Approximately 7.3 volts).

e. Turn off AC power.

f. Connect DVM from 1A3TP1 to 1A3RN6-9.

g. Turn on AC power and adjust 1A3R14 to read voltage recorded in step d.

h. Turn off AC power.

i. Remove DVM.

5.5.6 Helix Current Adjustment

a. Turn off AC power. Remove top cover and leave interlock switch open to prevent the high voltage from coming on.

b. Connect a DC power supply with a 1K resistor in series with the positive lead across 1A1R9. Connect the negative lead of the power supply to the left side of 1A1R9 and the positive lead to the right side of 1A1R9.

c. Connect DVM across 1A1R9.

d. Turn on AC power. Make sure interlock switch S1 is open.

e. Make sure the external power supply is adjusted to zero volts before turning on the external power supply.

f. Turn on the external power supply and adjust to read 2.5 VDC on DVM. The front panel meter should read 10 ma (5 segments). If not, adjust 1A3R19 to read 10 ma.

g. Turn off AC power supply and external DC supply.

h. Remove external power supply.

5.5.7 Helix Trip Adjustment

a. Repeat paragraph 5.5.6 steps a through e. (Note, interlock switch is open.)

b. Turn on external power supply.

c. Turn on H.V. control. Slowly adjust power supply voltage to 2.7 VDC while observing the helix trip fault light on the front panel display. At 2.6 VDC ±.1 VDC the helix fault light should light.

d. If not, check TWTA data sheet. Steps a-c are set to check a 10 mA trip point. Certain tubes require 15 mA trip point. Reduce the external power supply to zero volts DC. Adjust 1A3R2 fully CCW. Turn HV control off and then on. Leave the H.V. switch on.

e. Adjust the external DC supply to read 2.6 VDC ±.1 VDC for 10 mA trip point and 3.37 ± .1 VDC for 15 mA trip point. Adjust 1A3R2 CW until the helix fault light lights.

f. Turn off AC power.

g. Turn off external power supply and remove connections.

5.6 TROUBLESHOOTING PROCEDURES

The basic philosophy underlying the procedures in this section is that:

a. Hazards to personnel should be minimized.

b. Fault isolation is only required to the functional circuit block level (skilled technicians only would be servicing the unit).

c. Maximum use should be made of features incorporated into the TWTA.

5.6.1 General Fault Isolation

The TWTA incorporates features that facilitate fault isolation on the bench or in an operational configuration.

CAUTION

This amplifier uses an off-line regulator to develop the voltages used to operate the TWT. Extra precautions are necessary before the amplifier is serviced. It is necessary that an isolation transformer be used to provide AC power to the amplifier before servicing the unit. If an isolation transformer is not used, all voltage and scope measurements made on the Power Processor PCB (A2) will force the test

equipment to float at the line potential. If the test equipment is grounded, while an isolation transformer is not used, then damage will be induced in the TWTA. If the test equipment is not grounded, the test equipment will be hazardous because it will be at line potential.

Table 5-6 summarizes the indications that can be used directly for fault isolation. (0) indicates the control is in the OFF position or the LED indication is not lighted. (X) indicates the control or indicator is ON and (X0) indicates it does not make any difference. The column marked CONDITION indicates the status or probable source of the problem. The column marked REFER TO lists procedures or additional tables that require something more than use of the operational controls and indicators.

If there is a problem that was not resolved by the data in Table 5-6, the next logical step whould be to eliminate the low voltage supplies on the Power Processor PCB as the source. This will require a voltage check of the input to and output from four regulators (1A2U10, 1A2U11, 1A2U12, 1A2U13, 1A2U14). Table 5-7 provides the data required to make this check.

CAUTION

> The return for the 1A2U10, 1A2U11, and 1A2U12 supplies is above chassis ground.

If the input is OK and the output bad, replace the regulator. If both input and output good, look elsewhere in circuit. If input is bad, remove and replace the bridge (1A2CR3 or 1A2CR2) or transformer (1A1T2) as required.

TABLE 5-6

OVERALL FAULT ISOLATION INDICATIONS (LOCAL MODE)

CASE	FRONT PANEL SWITCHES		HELIX METER	LEDS					RF OUTPUT POWER	CONDITION OR MOST LIKELY CAUSE
	POWER ON/OFF	HV ON/OFF		PWR ON	STD BY	OPER	SUM FAULT	HELIX FAULT		
1	X	0	0	X	0	0	0	0	0	Normal during filament time delay.
2	X	0	0	X	X	0	0	0	0	Normal standby.
3	X	X	X	X	0	X	0	0	X	Normal operation.
4	X	X/0	0	X	0	0	X	0	0	Interlocks, or low line fault or logic PCB fault or bus detector fault. See Table 5-7 cases 1, 2, and 3.
5	X	X	0	X	0	0	X	0	0	TWT overtemperature fault.
6	X	X	MOMENTARY	X	0	0	X	X	0	Helix over current.
7	X	0	0	0	0	0	0	0	0	Prime power or fuse or AC PCB or A2U14 or A3S2. See Table 5-7, case 4.
8	X	X	X	0	0	0	0	0	X	Indicator circuits.
9	X	X	X	X	0	X	0	0	0	RF drive or TWT or A2Q11, Q12 and associated circuits.
10	X	X	X	X	0	0	0	0	0	Logic PCB or A3U1 or A3U3. Loose cable 1A2P1.
11	X	X	X	X	0	0	0	0	X	A3U8
12	X	X/0	0	X	0	0	0	0	0	A3U1 or A3U3.
13	X	X	0	X	0	X	0	0	X	A3U7 or A3M1 or A3R19 adjust.
14	X	X	0	X	0	X	0	0	0	A2Q5 or A2U3 or HV assembly. See Table 5-7 cases 1, 2, & 3.
15	X	X	X	X	X	X	X	0	0	A3U8
16	X	X	0	X	X	0	0	0	0	A3S1

X = ON
0 = OFF
X/0 = NO SIGNIFICANCE
0   X = STATE CHANGE

TABLE 5-7

REGULATOR MEASUREMENTS

REF.DES.	INPUT			OUTPUT		
	DVM ON POS	PINS NEG	READ VDC *	DVM ON POS	PINS NEG	READ VDC
U10	(1)	(3)	25	(2)	(3)	+12
U11	(1)	(3)	13	(2)	(3)	+5
U12	(3)	(1)	13	(1)	(2)	-5
U13	(1)	(3)	25	(2)	(3)	+15
U14	(1)	(3)	25	(2)	(3)	+12

( ) Pin No. of chip

* Input voltages are unregulated DC. Exact value depends on input line voltage.

5.6.2 Fault Isolation Using Test Equipment

Table 5-8 provides an expansion of some of the items in Table 5-6. The purpose of these procedures is to differentiate between multiple causes defined in Table 5-6. The same symbols are used in Table 5-7 as in Table 5-6. Table 5-7 refers to other procedures as required.

5.6.3 Summary Fault Indication

If the Summary Fault indicator is ON, there is a fault present or the Logic Card is malfunctioning. Proceed as follows:

a. Connect DVM from 1A3TP1 to 1A3TP3. If DVM reads Logic High (approximately 10.5), then a Low Line Fault is present:
    1. Check prime power.
    2. Check Low Line Detector on the power processor, U2 pin 13 and associated circuitry.

b. Connect DVM from 1A3TP1 to Anode 1A3CR4. If DVM reads Logic High (approximately10.5V), then check interlock switch or check remote interlock option. If Remote Control Option is not installed, make sure jumpers 1, 2 and 3 are installed on the Logic Card.

c. Connect DVM from 1A3TP1 to anode of 1A3CR5. If DVM reads high (10.5 VDC) then check TWT temperature switch on TWT.

    1. If the above checks indicate no faults present, remove and replace U6.
    2. If problem persists, replace Logic Card.

TABLE 5-8

FAULT ISOLATION USING TEST EQUIPMENT

CASE	POWER SWITCH	HV SWITCH	HELIX METER	PWR ON	STD BY	OPER	SUM FAULT	HELIX	RF POWER	TEST EQUIPMENT CONNECTION
1	X	X	0	X	0	X	0	0	0	A2Q5, or A2U3 or HV DVM across C26-Normal 70-120 VDC. Oscilloscope collector of Q11 to collector of Q12, 20 kHz square wave 140-300V pk to pk. If OK remove and replace HV Assy. If square wave not OK and 70-120 VDC across A2C26, check A1Q2, Q11, Q12, U4 and associated circuits. Remove and replace as required. No adj. required after repair. If both square wave and voltage across A2C26 not OK, check A2Q5, A2U3 and associated circuit. Adjust per 5.5.1a after repair of defective components.
2	X	X/0	0	X	0	0	X	0	0	Does not clear fault when HV switch changed to OFF. Check Local and Remote Interlock. If interlock OK place DVM across A2C26. If greater than 120 VDC rotate A2R33 counterclockwise to decrease voltage until summary fault light goes out. If light goes out see Section 5.5.1a for adjustments. If A2R33 adjustment does not change voltage A2Q5 is shorted or A2U3 and associated components are defective. Remove and replace as required. Adjust after repair per section 5.5.1a. If not 1, 2 above proceed per 5.6.3.
3	X	X	0	X	0	X	0	0	X	RF power level incorrect. (erratic, low or high). Could be Sw Reg, Conv, HV Mod. or HV Feedback. See 1,2 above for Sw Reg, Conv. HV Mod for feed back circuit. If erratic refer to 5.6.4. If low or high refer to adjustment procedure 5.5.1b. If this does not solve problem see 5.6.4.
4	X	0	0	0	0	0	0	0	0	DVM across A2U14-2, A2U14-3. Should be 12 VDC. If greater, replace A2AU14. If lower check voltage across A2C5. If 25 VDC +10% replace U14. If correct voltages, check interconnection of PCBs (A2J1). If connection OK check path for short. Refer to schematic.

TABLE 5-8 (Cont'd)

FAULT ISOLATION USING TEST EQUIPMENT

CASE	POWER SWITCH	HV SWITCH	HELIX METER	PWR ON	STD BY	OPER	SUM FAULT	HELIX	RF POWER	TEST EQUIPMENT CONNECTION
5	X	XO	XO	X	XO	XO	XO	XO	XO	Fan does not work. DVM across A2C17. 12 VDC. If low check for 25 VDC ± 1% across A2C5. If OK replace A2C12 or A2U13 or fan B1. (Refer to 5.6.5 for fan replacement procedure.

X = ON
0 = OFF
X/0 = NO SIGNIFICANCE

Cases 1, 2 and 3 require use of isolation transformer.

5.6.4 Switch Regulator Fault Isolation

a. Turn OFF AC power. Wait 30 seconds. Short 1A1TP1 to Chassis.

b. Disconnect 1A1P1 from High Voltage Module. (Disconnects TWT).

c. Remove 1A2U5. Removing 1A2U5 removes effects of the H.V. feedback amplifier.

d. Connect DVM across 1A2C26.

e. Remove shorting lead from 1A1TP1.

f. Turn on AC power, wait 3 minutes.

g. Turn on High Voltage and read approximately 120 VDC.

h. If not 120 VDC ± 5 VDC and 1A2R33 does not adjust the voltage, refer to Table 5-8, items 1 and 2.

i. If 120 ± 5 VDC, the problem is in the feedback path (U9, Q6, U5 and associated circuits).

j. Shut off AC power and wait 30 seconds. Install 1A2U5.

k. Connect oscilloscope between 1A2U9-6 and 1A2U9-4. Connect DVM to anode 1A2CR12.

l. Turn on AC power and wait 3 minutes.

m. Turn on H.V.

n. If voltage on the DVM is greater than +3V as less than 7V, adjust 1A2R19 in either direction. Oscilloscope levels should track adjustment. If oscilloscope levels do not track, remove and replace U9. Refer to 5.5.1a. for adjustment procedure after U9 replaced.

o. If replacement of U9 does not solve problem, shut off AC power and wait 30 seconds.

p. Connect a DVM across 1A1CR11.

q. Turn on AC power.

r. Voltage across 1A1CR11 should read about 9 VDC. If not, shut off AC power, replace 1A1CR11.

s. Short 1A1TP2 to chassis.

t. Check continuity of High Voltage lead from A1E1 to anode of 1A2CR12. If OK, proceed to step u.

u. Check 1A2Q6, 1A2U5 and associated circuit. Repair as required.

v. Remove test equipment and reconnect A1P3.

5.7 REMOVAL AND REPLACEMENT PROCEDURES

5.7.1 Fan Replacement

The fan is mounted on the rear panel of the TWTA and connected to the power supply with a Molex edge connector. If you are not equipped with proper tools to remove and insert the pins of the Molex connector, you will have to cut the leads to the old fan and splice in the new one. Proceed as follows:

a. Turn off AC power, wait 30 seconds and short 1A1TP1 to chassis.

b. Open the wire bundle between the fan and the Molex connector.

c. Remove air duct.

d. Remove the fan red lead pin (1A2P2-14) from the Molex connector with small flat screwdriver by pushing lead pin. Remove the fan blue lead from filter FL1-2.

e. Remove fan.

f. Install the new fan and insert the pin in the Molex connector, red to 1A2P2-14 and solder blue to FL1-2

g. Reinstall air duct.

5.7.2 TWT Replacement

a. Turn off AC power and disconnect TWTA from prime power source.

b. Remove top cover from TWTA.

c. Short 1A1TP1 to chassis.

d. Remove 1A1P1 (Figure 5-2).

e. Remove RF semi-rigid cables from TWT RF In and RF Out (Figure 5-2).

f. Set chassis on side with TWT above the power supplies.

g. Remove screws on the bottom of TWTA that secure the TWT heatsink to the chassis (9 places).

h. Lay TWTA flat with tube on top and remove TWT Heatsink Assembly.

i. Disassemble TWT from heatsink.

j. Coat the bottom surface of the replacement TWT with thermal compound (Wakefield or equivalent). A thin coat will do.

k. Reinstall tube by reversing steps (e) thru (j).

l. Adjust TWT voltages per 5.5.1 b, 5.5.2 (and 5.5.3 and 5.5.4 if the options are installed.

m. Remove shorting lead from 1A1TP1 and replace top covers.

n. Check RF output per section 5.4.

5.7.3 HV Assembly Replacement

a. Turn off AC power and wait 30 seconds.

b. Remove top cover.

c. Short 1A1TP1 to chassis.

d. Remove fiberglass cover from top of H.V. Assembly (A1), Figure 5-2.

e. Remove optional Grid (A5) or anode (A6) PCBs if installed.

f. Disconnect 1A1J3 and 1A1J1.

g. Remove nylon standoffs and one 6-32 screw from HV Assembly (Figure 5-2) and lift out H.V. PC Board.

h. Install replacement HV Assembly reversing steps g thru d.

i. Adjust heater and tube voltages per Sections 5.5.1 b, 5.5.2 (5.5.3 and 5.5.4) as required.

j. Remove test equipment and shorting leads as required.

k. Replace top cover, procedure complete.

5.7.4 Power Processor PCB Replacement

a. Turn off AC power and disconnect prime power.

b. Remove top cover and short 1A1TP1 to chassis. Short the terminals of 1A1C1.

c. Remove 1A2J1, 1A2J2 and 1A2J3.

d. Remove the 8-32 screws (6 places) holding the power Processor PCB to chassis (Figure 5-2).

e. Coat the bottom of the heatsink of the replacement unit with thermal compound (Wakefield or equivalent).

f. Install PCB by reversing above procedure.

g. Adjust per 5.5.1 a and 5.5.1 b.

5.7.5 Logic Card

a. Turn off AC power and wait 30 seconds.

b. Remove top cover.

c. Disconnect 1A3J1, 1A3J2 and 1A3J3 (Figure 5-2).

d. Remove top rail screw (Figure 5-2) 3 places, one at each end and one in center.

e. Remove top rail.

f. Remove left Front Panel Assembly (Control Indicator Assembly) (Fig. 5-2).

g. Refer to Figure 5-4. Remove nut from between PWR ON/OFF and HV ON/OFF switches.

h. Remove two 6-32 nuts from rear of assembly (Figure 5-4).

i. Remove Logic Card from Front Panel. (Figure 5-4)

j. Install replacement Logic Card by reversing steps (a) through (i).

NOTE

Logic Cards are preset at factory.

k. Operate TWTA per Section ?.4. If any problems, check adjustments per 5.5.5, 5.5.6 and 5.5.7.

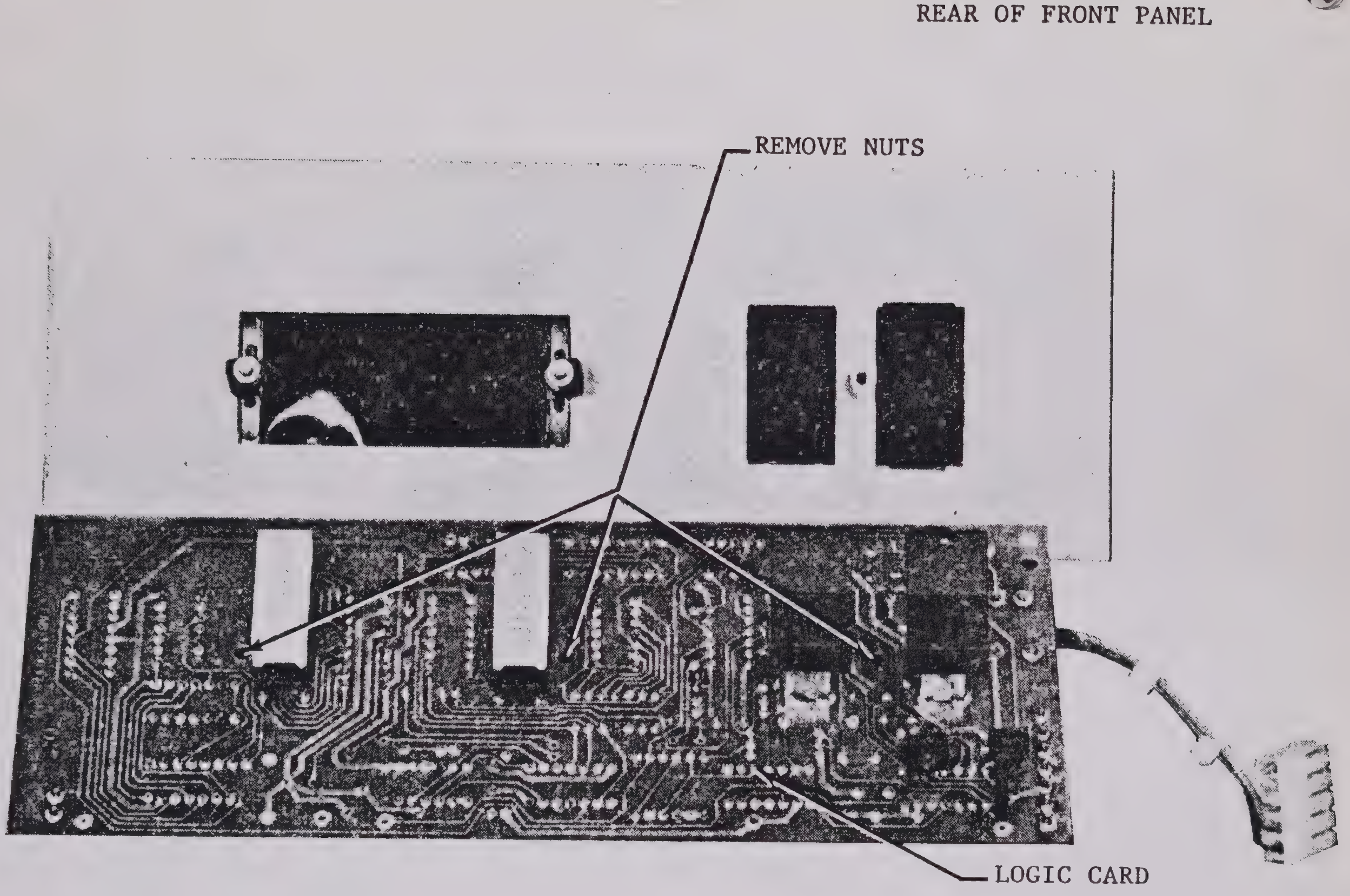

REAR OF FRONT PANEL
REMOVE NUTS
LOGIC CARD

FIGURE 5-4 CONTROL INDICATOR ASSY REMOVAL/REPLACEMENT

NOTE

The preceding procedures covers the field replaceable units. Contact Varian MCSD for instructions relating to items not covered in this manual or send unit to factory per instructions in Section 4.4.

SECTION 6

DRAWINGS AND SCHEMATICS

6.1 GENERAL

This section includes the assembly drawings and schematics for the "K-Series" amplifiers. This section is organized in two parts; Part A - drawings that are specific to the basic model numbers defined in Table 1-1; and Part B - drawings that are common to the entire "K-Series". Please note that all the drawings have been placed in numerical order at the end of this section.

Material (Parts) Lists are included with the drawings. The Lists of Material are denoted by the prefix LM before the part number, e.g., LM135216 is the List of Material for drawing 135216.

6.2 DRAWINGS SPECIFIC TO INDIVIDUAL MODEL NO.

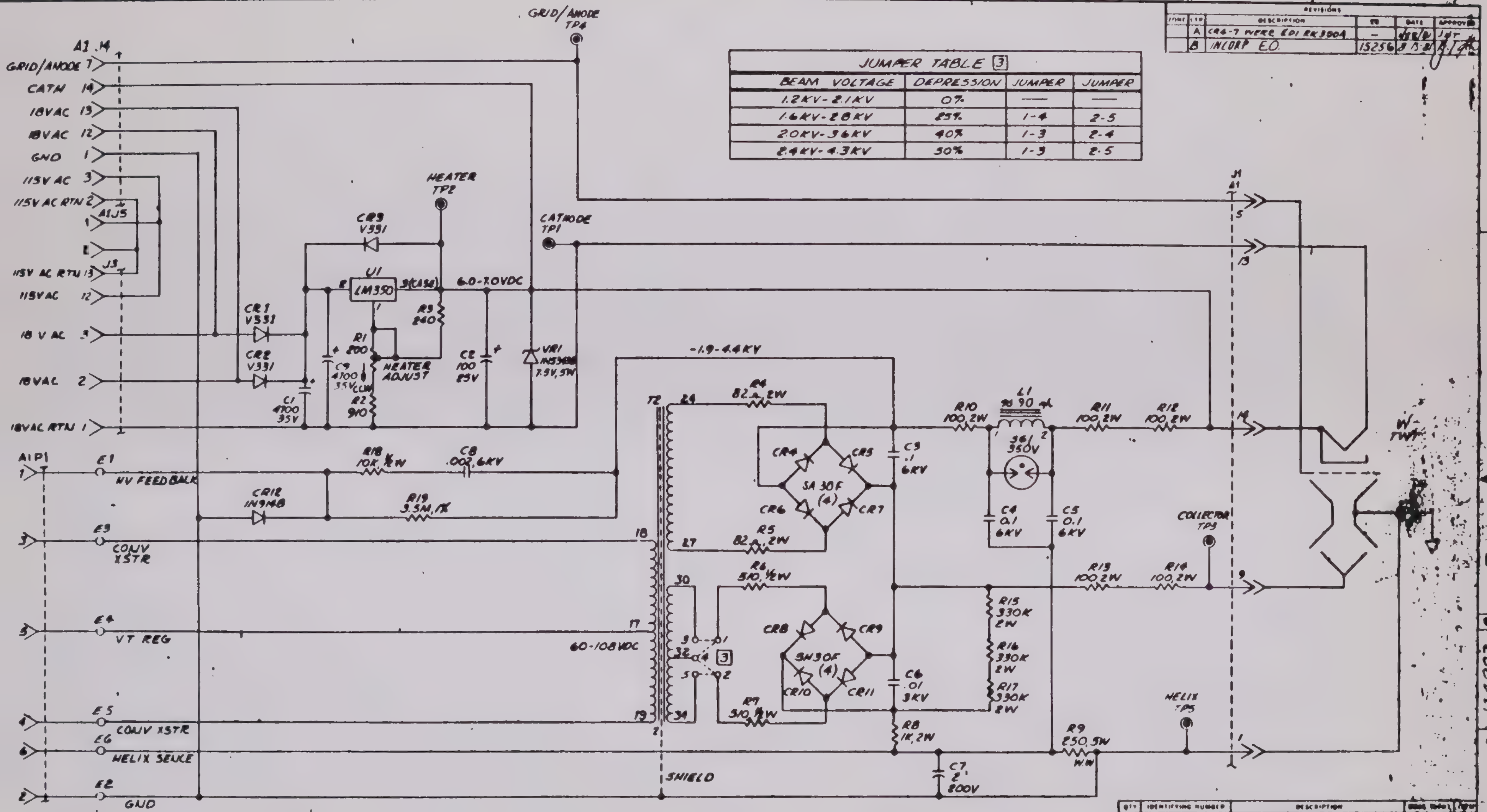
6950K1 Series	01000376
6970K1 Series	01000377
6980K1 Series	01000378
6941K1 Series	01000379
6951K1 Series	01000380
6951K2 Series	01000381
6961K1 Series	01000382
6961K2 Series	01000383
6981K1 Series	01000384
6991K1 Series	01000385
6991K3 Series	01000386
6990K1 Series	01000592
6998K1 Series	01000525

6.3 DRAWINGS COMMON TO THE "K-SERIES"

	Power Supply Assembly	E135216-00
	Outline Power Supply	D135223
	Power Supply Schematic	E135228
A1	High Voltage Module Assembly	E135190-00
	High Voltage Module Schematic	D134993
A2	Power Processor PCB Assembly	E135215-00
	Power Processor PCB Schematic	E135212
A3	Fault Logic Timer Assembly	D135018-00
	Fault Logic Timer Schematic	E135015
A5	Grid Supply/Regulator Assembly	D135195
	Grid Supply/Regulator Schematic	D135192
A6	Anode Supply Assembly	D135199
	Anode Supply Schematic	C135196

NOTE: THE ABOVE LIST OF DRAWINGS AND SCHEMATICS ARE ARRANGED IN NUMERICAL ORDER.

ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	CR4-7 WERE EDI RK300A	—	4/28/81	JHT
	B	INCORP E.O.	15256	8-13-81	


A1 J4
GRID/ANODE 7
CATH 14
18VAC 13
18VAC 12
GND 1
115V AC 3
115V AC RTN 2
A1J5
1
L
115V AC RTN 13
J3
115VAC 12
18 V AC 3
18VAC 2
18VAC RTN 1
A1P1
1
E1
HV FEEDBACK
E3
3
CONV XSTR
E4
5
VT REG
E5
4
CONV XSTR
E6
6
HELIX SENSE
E2
2
GND
CR1 V331
CR2 V331
C1 4700 35V
CR3 V331
U1 LM350
2
3(CASE)
1
HEATER TP2
R3 240
R1 200
HEATER ADJUST
C9 4700 35V
R2 910
C2 100 25V
6.0-7.0VDC
GRID/ANODE TP4
CATHODE TP1
VR1 1N5343B 7.5V, 5W
R18 10K, ½W
C8 .002, 6KV
CR12 1N914B
R19 3.3M, 1%
-1.9-4.4KV
T2
24
27
18
17
19
30
34
60-108VDC
SHIELD
R4 82Ω, 2W
R5 82Ω, 2W
CR4
CR5
CR6
CR7
SA 30F (4)
C3 .1 6KV
R6 510, ½W
R7 510, ½W
1
4
2
3
5
32
CR8
CR9
CR10
CR11
SN30F (4)
C6 .01 3KV
R8 1K, 2W
C7 2 800V
R10 100, 2W
L1 90 μH
3
1
2
361 350V
C4 0.1 6KV
C5 0.1 6KV
R11 100, 2W
R12 100, 2W
R13 100, 2W
R14 100, 2W
R15 330K 2W
R16 330K 2W
R17 330K 2W
R9 250, 5W W.W
COLLECTOR TP3
HELIX TP5
J1 A1
5
13
14
9
1
W-TWT

JUMPER TABLE [3]

BEAM VOLTAGE	DEPRESSION	JUMPER	JUMPER
1.2KV-2.1KV	0%	—	—
1.6KV-2.8KV	25%	1-4	2-5
2.0KV-3.6KV	40%	1-3	2-4
2.4KV-4.3KV	50%	1-3	2-5

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTOR VALUES ARE IN OHMS, ¼W COMP.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
[3] SEE JUMPER TABLE.

QTY	IDENTIFYING NUMBER	DESCRIPTION

LIST OF MATERIALS

135190	135216
NEXT ASSEMBLY	USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .03
3PL ± .010
FRAC ± 1/64
ANG ± 1°
SURFACE FINISH
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER

DR		6-11-81
CHK		4/9/81
APPD	L Bauman	4/9/81
APPD		

DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

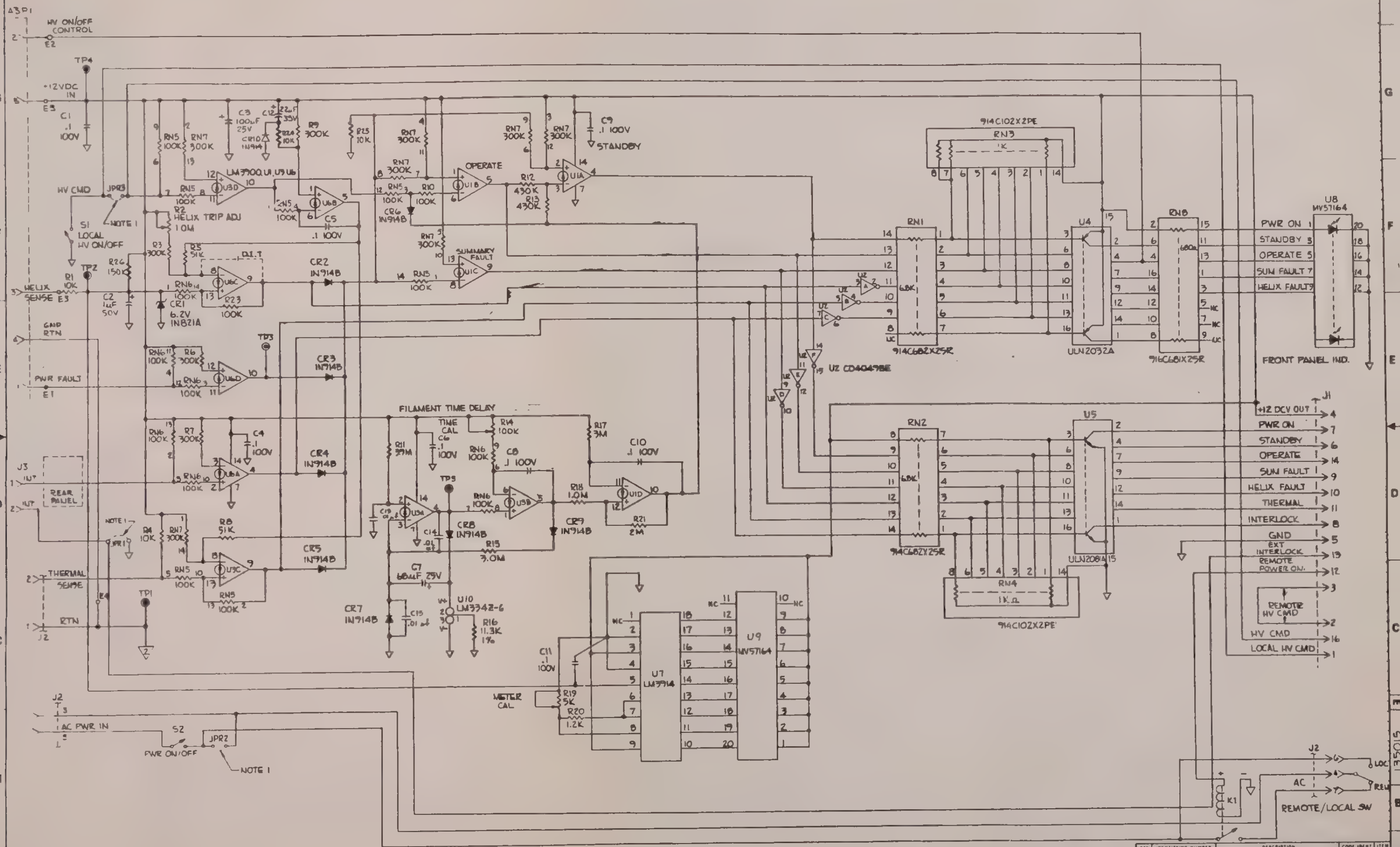
varian [redacted]

SCHEMATIC
HIGH VOLTAGE PCB

SIZE	CODE IDENT NO		
D	59782	134993	B

SCALE — SHEET 1 1

134993


HV ON/OFF CONTROL
E2
TP4
+12VDC IN
E3
C1 .1 100V
HV CMD
JPR3
NOTE 1
S1 LOCAL HV ON/OFF
HELIX SENSE E3
R1 10K
TP2
R26 150K
C2 1µF 50V
CR1 6.2V IN821A
GND RTN
PWR FAULT
E1
J3
REAR PANEL
THERMAL SENSE
E4
TP1
RTN
J2
RN5 100K
RN7 300K
C3 100µF 25V
CR10 IN914
R9 300K
R24 10K
R25 10K
LM3900 U1, U3 U6
U3D
U6B
C5 .1 100V
R2 HELIX TRIP ADJ 1.0M
R3 300K
R5 51K
D.I.T.
U6C
R23 100K
RN6 100K
R6 300K
U6D
TP3
R7 300K
C4 .1 100V
U6A
R8 51K
R4 10K
U3C
CR2 IN914B
CR3 IN914B
CR4 IN914B
CR5 IN914B
OPERATE
U1B
R10 100K
CR6 IN914B
SUMMARY FAULT
U1C
R12 430K
R13 430K
U1A
C9 .1 100V
STANDBY
FILAMENT TIME DELAY
TIME CAL
C6 .1 100V
R11 39M
R14 100K
C8 .1 100V
R17 3M
C10 .1 100V
TP5
U3A
CR8 IN914B
U3B
R18 1.0M
U1D
R21 2M
CR9 IN914B
R15 3.0M
C7 68µF 25V
C14 .01
CR7 IN914B
C15 .01
U10 LM334Z-6
R16 11.3K 1%
C11 .1 100V
METER CAL
R19 5K
R20 1.2K
U7 LM3914
U9 MV57164
NC
914C102X2PE
RN3
1K
RN1
68K
914C682X25R
U2
U2 CD4049BE
U4
ULN2032A
RN8
680
916C681X25R
U8 MV57164
PWR ON
STANDBY
OPERATE
SUM FAULT
HELIX FAULT
FRONT PANEL IND.
RN2
68K
914C682X25R
U5
ULN2081A
RN4
1K Ω
914C102X2PE
J1
+12 DCV OUT
PWR ON
STANDBY
OPERATE
SUM FAULT
HELIX FAULT
THERMAL
INTERLOCK
GND
EXT INTERLOCK
REMOTE POWER ON
REMOTE HV CMD
HV CMD
LOCAL HV CMD
J2
AC PWR IN
S2
PWR ON/OFF
JPR2
NOTE 1
K1
AC
LOC
REM
REMOTE/LOCAL SW

2. ALL RESISTORS ARE CARBON COMP, 1/4W, 5% OR AS INDICATED.
1. JUMPER 1, 2 & 3 ARE TO BE REMOVED WHEN REMOTE CONTROL IS USED.
NOTES

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA

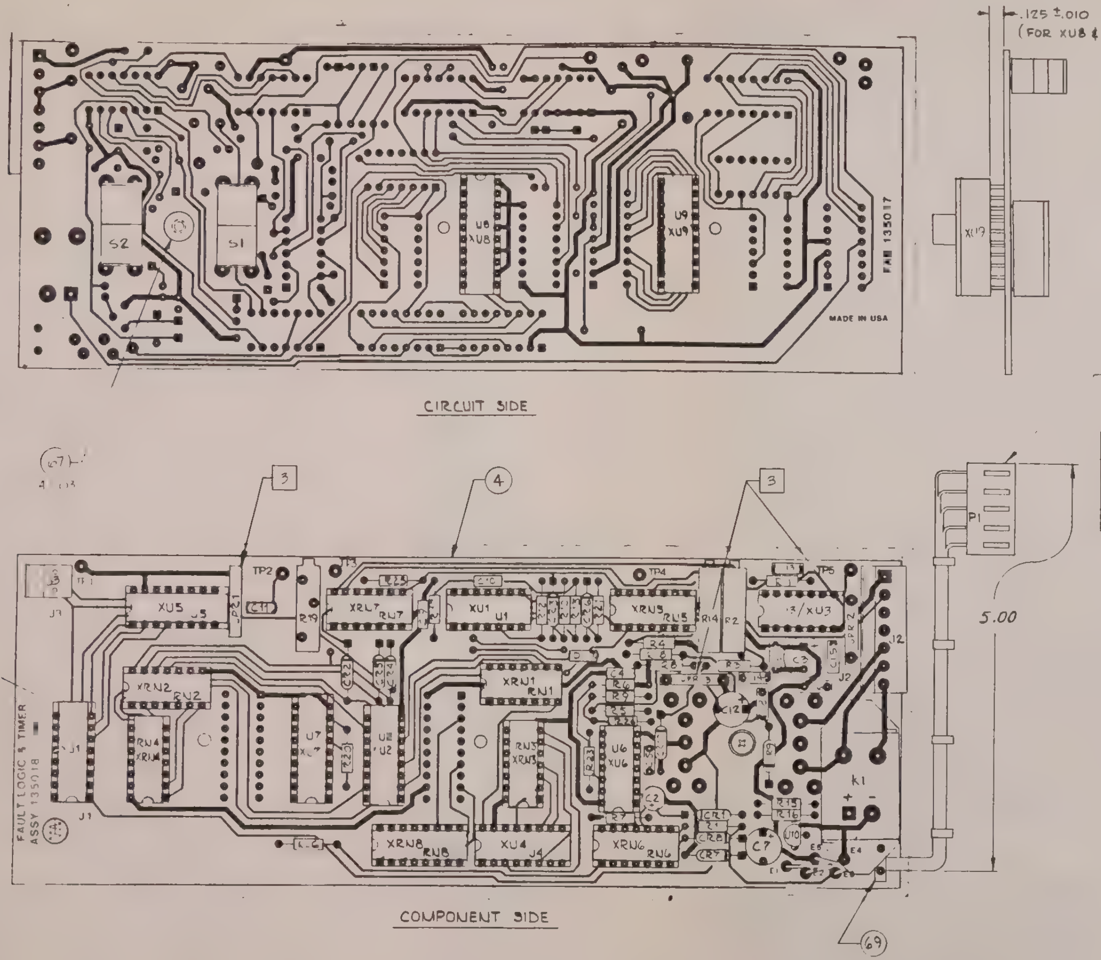
SCHEMATIC
FAULT LOGIC & TIMER

C135018
NEXT ASSEMBLY
USED ON
APPLICATION

DR DT 1 24 80
CHK 6-11-80
APPD
APPD 5-1-81

SIZE E
CODE IDENT NO 59782
135015
A
SCALE —
SHEET 1 OF 1

REVISIONS					
ZONE	TR	DESCRIPTION	EO	DATE	APPROVED
	A	REVISED	—	1/26/81	
	B	INCORP E.O. 15240	15260	8 13 81	
	C	INC EO	15493	11-17-81	USM



.125 ±.010
(FOR XU8 & XU9 ONLY)
FAB 135017
MADE IN USA
S2
S1
U8
XU8
U9
XU9
XU7
42
41
67
5.00
P1
3
4
3
69
XU5
J3
TP2
XRL7
RL7
XU1
U1
XRN5
RL5
TP4
TP5
U3/XU3
J2
J12
XRN2
RN2
XRN1
RN1
XRN4
XU7
U7
XU2
U2
RN3
XRN3
U6
XU6
C12
K1
XRN8
RN8
XU4
U4
XRN6
RN6
C7
U10
E1
E2
E3
E4
FAULT LOGIC & TIMER
ASSY 135018
J1
2

CIRCUIT SIDE

COMPONENT SIDE

WIRE NO.	DESTINATION FROM	TO	PART NUMBER	DESCRIPTION TYPE	AWG	COLOR			LGTH
1	P1-1	A3-E1	81-288 711	E E	24	BRN			A/R
2	P1-2	A3-E2	722	E E	24	RED			A/R
3	P1-3	A3-E3	733	E E	24	ORG			A/R
4	P1-4	A3-E4	744	E E	24	YEL			A/R
5	P1-5	A3-E5	81-288 755	E E	24	GRN			A/R

3 JUMPERS 1, 2 & 3 ARE TO BE REMOVED WHEN REMOTE OPTION IS USED

2 MARK WITH CURRENT DASH NO. & REVISION LETTER OF ASSEMBLY.

1. ASSEMBLE PER VARIAN WORKMANSHIP STD 87-800-799.

NOTES:

SEE SEPARATE LIST OF MATERIALS-LM 135018

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS	R602	

NEXT ASSEMBLY	USED ON
E135216	
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005
FRAC ± 1/64
ANG ± 1°
SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER

DR	Antonio Sean	1-12-81
CHK	Diez	2-6-81
APPD	L Barnes	2-6-81
APPD	Jun Chail	11-20-81

DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA

ASSEMBLY
FAULT LOGIC TIMER

SIZE D
CODE IDENT NO 59782
135018
C
SCALE 2/1
SHEET 1 OF 1
SUPERSEDES

SHEET 1 5

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: FAULT LOGIC & TIMER ASSY	LM 135	REV C
CODE IDENT NO 59782.	APPROVAL	DATE	11/24/81	

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
135216			A	R24 WAS D.I.T., ADDED ITEMS 11 & 32. ITEM 60 WAS TEXAS INSTR.	—	1/22/81	5-2013 JHT
			B	INCORP E.O 15240	15260	8-13-81	
			C	INC. EO	15480	11-17-81	DS/ JR

R602

REVISION STATUS

SHEET																											
LTR																											
SHEET																											
LTR																											
SHEET																											
LTR																											

FORM 1758 01 375

SHEET 2 OF

varian	MICROWAVE EQUIPMENT OPERATIONS	FAULT LOGIC & TIMER ASSY			LM 135018				REV C
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO.			
						-00	-01	-02	-03
1		SCHEMATIC	E135015			ref			
2									
3									
4		FABRICATION	C135017			1			
5									
6	C1,4-6, C8-11	CAPACITOR, CERAMIC, .1 µf 100V	41-229952		CK06BX104K	8			
7	C2	CAPACITOR, TANT., 1 µf 50V	41-609459	SPRAGUE	196D105X9050HA1	1			
8	C3	CAPACITOR, ELECT., 100 µf 25V	41-503905	SPRAGUE	503D107F025NC	1			
9	C7	CAPACITOR, TANT., 68 µf 25V	41-609448	SPRAGUE	196D86X9025TE4	1			
10	C12	CAPACITOR, TANT., 22uf, 35V	41-609451	SPRAGUE	196D226X9035PE4	1			
11	C13-15	CAPACITOR, CER, .01uf, 100V	41-229963		CK05BX103K	3			
12									
13	CR1	DIODE, ZENER 6.2V	66-310821		1N821A	1			
14	CR2-10	DIODE, SIGNAL	66-320914		1N914B	9			
15									
16	JPR1-3	JUMPER	51-452939	CAMBION	461-2872-05-03-10	3			
17									
18	R25, 24 R1,4	RESISTOR, COMP., 10K 1/4W 5%	32-301510		RC07GF103J	4			
19	R2	RESISTOR, VARIABLE 1M	36-792314	BOURNS	3006P-1-105	1			
20	R3,6, R7,9	RESISTOR, COMP., 300K 1/4W 5%	32-301630		RC07GF304J	4			
21	R5,8	RESISTOR, COMP., 51K 1/4W 5%	32-301551		RC07GF513J	2			

FORM 1758 02-375

SHEET 3 OF

varian	MICROWAVE EQUIPMENT OPERATIONS	FAULT LOGIC & TIMER ASSY	LM 135018	REV C

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO	MFG	MFG OR MS PART NO	QTY/DASH NO -00	-01	-02	-03
22	R10,23	RESISTOR, COMP., 100K 1/4W 5%	32-301610		RC07GF104J	2			
23	R11	RESISTOR, COMP., 3.9M 1/4W 5%	32-301739		RC07GF395J	1			
24	R12,13	RESISTOR, COMP., 430K 1/4W 5%	32-301643		RC07GF434J	2			
25	R14	RESISTOR, VARIABLE 100K 3/4W	36-792215	BOURNS	3006P-1-104	1			
26	R15,17	RESISTOR, COMP., 3M 1/4W 5%	32-301730		RC07GF305J	2			
27	R16	RESISTOR, M.F., 11.3K 1/8W 1%	31-225113		RN55	1			
28	R18	RESISTOR, COMP., 1M 1/4W 5%	32-301710		RC07GF105J	1			
29	R19	RESISTOR, VARIABLE 5K 3/4W 10%	36-792218	BOURNS	3006P-1-502	1			
30	R20	RESISTOR, COMP., 1.2K 1/4W 5%	32-301412		RC07GF122J	1			
31	R21	RESISTOR, COMP., 2M, 1/4W, 5%	32-301720		RC07GF205J	1			
32	R26	RESISTOR, COMP, 150K, 1/4W, 5%	32-301615		RC07GF154J	1			
33									
34									
35	RN1,2	RESISTOR NETWORK, 6.8K	31-400017	SPRAGUE	914C682X2SR	2			
36	RN3,4	RESISTOR NETWORK, 1K	31-400068	SPRAGUE	914C102X2PE	2			
37	RN5,6	RESISTOR NETWORK, 100K	31-400023	ALLEN-BRADLEY	314B104	2			
38	RN7	RESISTOR NETWORK, 330K	31-400066	ALLEN-BRADLEY	314B334	1			
39	RN8	RESISTOR NETWORK, 680Ω	31-400067	SPRAGUE	916C681X2SR	1			
40									
41		CONN. CONTACT SOCKET	51-407112	MOLEX		5			
42	P1	CONNECTOR	51-407016	MOLEX	09-50-3051	1			

SHEET 4 OF

varian	MICROWAVE EQUIPMENT OPERATIONS	FAULT LOGIC & TIMER ASSY	LM 135018	REV C

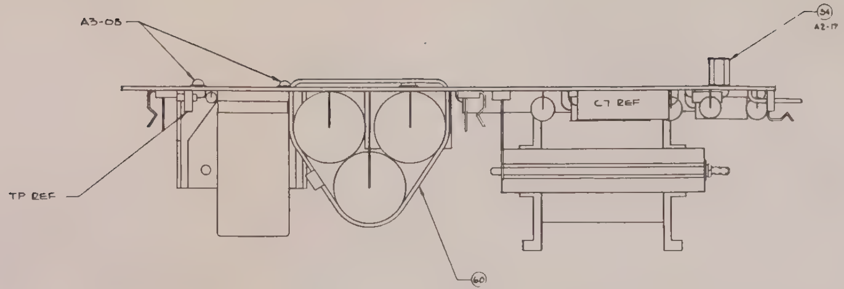
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO -00	-01	-02	-03
43	S1,2	SWITCH - SPDT	71-260064	C&K	7101J3V6Q	2			
44									
45	K1	RELAY	72-999 020	SIGMA	226RE-1-12A1	1			
46									
47	U1,3,6	I.C.-AMPL	62-600241	NATIONAL SEMI-CONDUCTOR	LM3900N	3			
48	U2	I.C.-BUFFER/LEVEL CONVERTER, HEX INVERTING	62-600032	RCA	CD4049UBE	1			
49	U4	I.C.-TRANSISTOR NETWORK	62-601534	SPRAGUE	ULN2032A	1			
50	U5	I.C.-TRANSISTOR NETWORK	62-601535	SPRAGUE	ULN2081A	1			
51	U7	I.C.-DOT, BAR DISPLAY DRIVER	62-601536	NATIONAL SEMI-CONDUCTOR	LM3914N	1			
52	U8,9	I.C., BAR GRAPH DISPLAY	67-480199	GENERAL INSTRUMENTS	MV57164	2			
53	U10	I.C., CURRENT SOURCE	62-601593	NATIONAL SEMI-CONDUCTOR	LM234Z-6	1			
54									
55									
56									
57 ·	YAN1,2 3-7,XU1,3,6	SOCKET, I.C. - 14 PIN	54-634007		SAE#1-SW3800-14B-W	10			
	XU1,3,6								
58	XRN8, XU2,4,5	SOCKET, I.C. - 16 PIN	54-634008		SAE#1-SW3800-16-B-W	4			
59	XU7	SOCKET, I.C. - 18 PIN	54-634059	TEXAS INST.	C84-18-02	1			
60	XU8,9	SOCKET, I.C. - 20 PIN	54-910379	CIRCUIT ASSY	CA-203-101WW	2			
61	XJ1	SOCKET. IC-16 PIN	54-634023	CKT ASSY	CA-165-10SD	1			

SHEET 5

varian	MICROWAVE EQUIPMENT OPERATIONS	FAULT LOGIC & TIMER ASSY	LM 135018	REV C

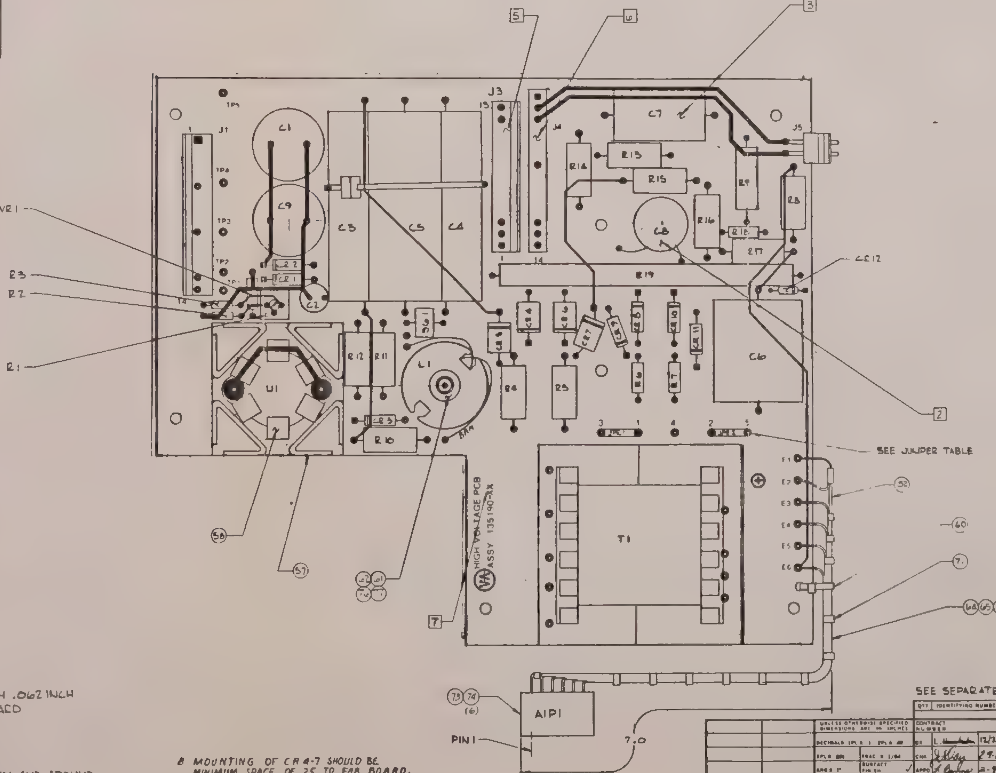
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO	QTY, DASH NO -00	-01	-02	-03
62	J2	CONNECTOR, 7 PIN	51-411 018	MOLEX	09-65-1071	1			
63	J3	CONNECTOR, 2 PIN	51-407017	MOLEX	09-65-1021	1			
64									
65									
66									
67		STANDOFF, #4-40 x 5/8 LG.	22-429915	R.A.F. ELECTRONIC HDWR	2059-440-B-1	1			
68									
69		CLAMP, CABLE TIE	22-119650	PANDUIT	SSTIM	1			
70									
71									
72									
73									
74									
75									
76									
77									
78									
79									
80									
81									
82									

ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	B	INCORP EO 15298	15261	8-13-8	
	C	INCORP EO	15281	9-4-81	
	D	UPDATED REV LTR	15366	2-2-8	
	E	INC EO	15411	10 M 8	KK
	F	INC EO	15472	11-19-8	
	G	INC EO	15525		


A3-08
(54)
A2-17
C7 REF
TP REF
(60)

JUMPER TABLE

BEAM VOLTAGE	DEPRESSION	JUMPER	JUMPER
1.2KV-2.1KV	0%	—	—
1.6KV-2.8KV	25%	1-4	2-5
2.0KV-3.6KV	40%	1-3	2-4
2.4KV-4.3KV	50%	1-3	2-5


5
6
3
J3
13
J4
C7
J5
J1
1
TP5
TP4
TP3
TP2
TP1
C1
C9
C3
C5
C4
R14
R13
R15
R9
R8
R16
C8
R18
R17
R19
1
14
CR12
VR1
R3
R2
CR2
CR1
C2
12
R1
U1
R12
R11
VR1
L1
CR3
R10
CR4
CR5
CR6
CR7
CR8
R4
R5
CR9
CR10
CR11
R6
R7
C6
2
3
1
4
2
5
SEE JUMPER TABLE
E1
E2
E3
E4
E5
E6
(52)
(60)
(7)
T1
(58)
(57)
(62)(61)
(63)
HIGH VOLTAGE PCB ASSY 135190-XX
7
(64)(65)(66)(67)
(73)(74)
(6)
A1P1
PIN 1
7.0

WIRE LIST

DESTINATION			DESCRIPTION			VARIAN PART NO
	FROM	TO	TYPE	AWG	COLOR	
1	P-	A1-E1	COAXIAL CABLE		CENTER CONDUCTOR	01000110-01
2	P-2	A1-E2			SHIELD	
3	P-3	A-E3	EE	20	ORN	81-288828
4	P-4	A-E4	EE	20	YEL	81-288829
5	P-5	A-E5	EE	20	GRN	81-288830
6	P-6	A1-E6	EE	20	BLU	81-288831

[7] MARK WITH CORRECT DASH NO & CURRENT REVISION LETTER OF PCB ASSY.

[6] REMOVE PINS 4 THRU 6 & 8 THRU 11 FROM J4

[5] REMOVE PINS 3 THRU 11 FROM J3

4. RESISTORS R4,5,8 THRU 11 TO BE MOUNTED WITH .062 INCH CLEARANCE BETWEEN COMPONENT AND BOARD

[3] MOUNT C7 FLAT AGAINST BOARD

[2] MOUNT C8 PARALLEL WITH BOARD

1. APPLY THERMAL COMPOUND ITEM (55) BETWEEN AND AROUND HEATSINKS ITEM (57)(58)

8 MOUNTING OF CR4-7 SHOULD BE MINIMUM SPACE OF .25 TO FAB BOARD.

SEE SEPARATE LIST OF MATERIALS-LM135190

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
LIST OF MATERIALS			R 602	

		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		CONTRACT NUMBER		
		DECIMALS 1PL ± 1 2PL ± .02		DR	L.	12/2/80
		3PL ± .005	FRAC ± 1/64	CHK		2-9-81
		ANG ± 1°	SURFACE FIN 63 ✓	APPD		2-9-81
		MATERIAL		APPD		1/9/81
E135216				DESIGN ACTIVITY APPROVAL		
NEXT ASSEMBLY	USED ON	SPEC NO		CUSTOMER APPROVAL		
APPLICATION		FINISH				

varian MCSD

HIGH VOLTAGE
PCB ASSEMBLY

SIZE	CODE IDENT NO		
E	59782	135190	G

SCALE 1/1 SHEET 1 OF 1

SUPERSEDES

SHEET 1 OF

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE. HIGH VOLTAGE PCB ASSY A1	LM 135190	REV H
CODE IDENT NO 59782	APPROVAL Juin Cirik	DATE 5-11-81		

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
			A	ITEM 13 MFTR & PART NO. WAS EDI RK300A.	EKO	1/22/81	JHT JWB
			B	INCORP E.O. 15261	15248	8-13-81	[illegible]
			C	INCORP EO	15281	9-4-81	[illegible]
			D	INC EO	15366	9-19-81	AE/JR
			E	INC E.O.	15411	10-19-81	KK/JR
			F	INC. EO.	15472	11-19-81	JS/JR
			G	INC. EO	15525	12-21-81	JS/ZL
			H	INC EO	15656	2/18/82	KB/ZL

R602

REVISION STATUS

SHEET																											
LTR																											
SHEET																											
LTR																											
SHEET																											
LTR																											

FORM 1758 01 375

SHEET 2 5

varian	MICROWAVE EQUIPMENT OPERATIONS	HIGH VOLTAGE PCB ASSY			LM 135190	REV H			
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
1		SCHEMATIC	D134993			ref			
2		SCHEMATIC, HIGH VOLTAGE PCB	D01000524				/		
3		FABRICATION, PCB	C135189			1	/		
4									
5									
6	C1,9	CAPACITOR, ALUM., 4700 µf 35V	41-503907	SPRAGUE	503D478F035UK	2	2		
7	C2	CAPACITOR, ELECT, 100 µf 25V	41-503905	SPRAGUE	503D107F025NC	1	/		
8	C3-5	CAPACITOR, MYLAR W.F., 0.1 µf 6KV	41-719305	TRW	X675HV104960W2	3	3		
9	C6	CAPACITOR, .01 µf 3KV	41-199802	CUSTOM ELECTRONICS	CGR1A-302103K	1	/		
10	C7	CAPACITOR, MYLAR W.F., 2 µf 200V	41-729997	TRW	X663F20592W2	1	/		
11	C8	CAPACITOR, CER., .002 µf 6KV	41-299888	CENTRALAB	DD60-202	1	/		
12									
13									
14	CR1-3	DIODE	66-396931	VARO INC.	V331	3	3		
15	CR4-11	DIODE	66-393-329	EDI	RG300A	8	8		
16	CR12	DIODE	66-320914		1N914B	1	/		
17	J5	CONNECTOR, 2 PIN, RT. ANGLE	51-407186	MOLEX	09-75-1021	1	/		
18	J1	CONNECTOR, 14 PIN	51-411010	MOLEX	09-65-1141	1	/		
19									
20	J3	CONNECTOR, 13 PIN	51-411019	MOLEX	09-65-1131	1	/		
21	J4	CONNECTOR, 14 PIN	51-411009	MOLEX	09-67-2149	1	/		

varian	MICROWAVE EQUIPMENT OPERATIONS	HIGH VOLTAGE PCB ASSY	LM 135190	REV H

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO	MFG	MFG OR MS PART NO	QTY. DASH NO. -00	-01	-02	-03
22	JPR1,2	JUMPER	51-452939	CAMBION	461-2872-05-03-10	2	2		
23									
24									
25	L1	FILTER CHOKE	C135224			1	1		
26									
27									
28	R1	RESISTOR, VARIABLE 200Ω	36-797912	BECKMAN	72PR200	1	1		
29	R2	RESISTOR, COMP., 910Ω 1/4W 5%	32-301391		RC07GF911J	1	1		
30	R3	RESISTOR, COMP., 240Ω 1/4W 5%	32-301324		RC07GF241J	1	1		
31	R10-14	RESISTOR, COMP., 100Ω 2W 5%	34-401310		RC42GF101J	5	5		
32	R6,7	RESISTOR, COMP., 510Ω 1/2W 5%	32-201351		RC20GF511J	2	2		
33	R8	RESISTOR, COMP., 1K 2W 5%	34-401410		RC42GF102J	1	1		
34	R9	RESISTOR, W.W., 250Ω 5W 1%	31-599512	OHMITE	45F251	1			
35	R15-17	RESISTOR, COMP., 330K 2W 5%	34-401633		RC42GF334J	3	3		
36	R18	RESISTOR, COMP., 10K 1/2W 5%	32-201510		RC20GF103J	1	1		
37	R19	RESISTOR, M.F., 3.5M 5-1/4W 1%	31-600653	PYROFILM	PVC400	1	1		
38	R4,5	RESISTOR COMP 82Ω 2W,5%	34-401282			2	2		
39	R9	RESISTOR. W.W. 100Ω 3W, 1%	31-599720				1		
40									
41	SG1	SPARK GAP, 350V	55-500160	SIEMENS	B1-A350	1	1		
42									

SHEET 4 OF

varia	MICROWAVE EQUIPMENT OPERATIONS	HIGH V AGE PCB ASSY	LM	135190	REV H

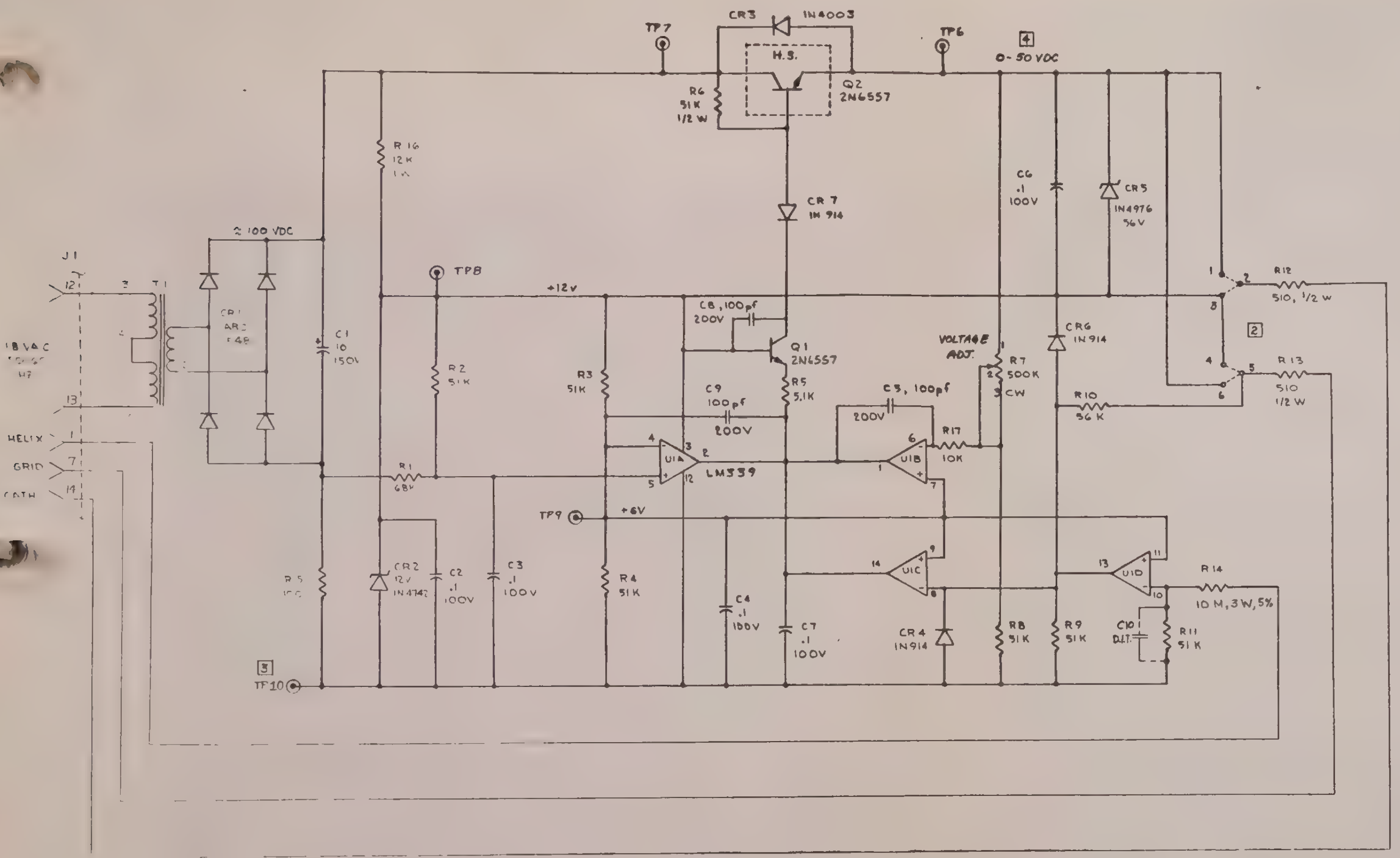
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART	QTY/DASH NO. -00	-01	-02	-03
43	TI	HIGH VOLTAGE XFMR	D135184			1	1		
44									
45	TP1-5	TEST JACK (RED)	51-451861	E.F.JOHNSON	105-0852-001	5	5		
46									
47									
48	U1	REGULATOR, ADJUSTABLE VOLTAGE	62-601329	NATIONAL SEMICONDUCTOR	LM350K	1	1		
49									
50									
51	VR1	DIODE, BREAKDOWN 7.5V, 5W	66-325343		1N5343B	1	1		
52		ASSY, CABLE, COAX	B-01000111			1	1		
53									
54		STANDOFF-#6-32 X 3/8LG	22-429904	RAF	2106-632-B-1	1	1		
55		THERMAL COMPOUND	88-298900	WAKEFIELD	120-8	A/R	A/R		
56									
57		HEATSINK- TO-3	66-901006	AAVID	5690C-3	1	1		
58		HEATSINK- TO-3	66-901007	AAVID	5791C	1	1		
59									
60		TIE WRAP	22-119654	PANDUIT	SST3S	1	1		
61		WASHER, NYLON	14-999725			1	1		
62		SCREW-#6-32X 1 1/4" LG	12-222006-22			1	1		
63		FLAT WASHER #6	14-122006			1	1		

varian	MICROWAVE Amplifier Subsystems	HIGH VOLTAGE PCB ASSY			LM [illegible]		RI H		

SHEET 5 OF 5

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO	MFG	MFG OR MS PART NO	QTY DASH NO -00	01	02	03
64		WIRE, TEFLON INS, BLUE	81-288766			A/R	A/R		
65		WIRE, " " " , GRN	81-288755			A/R	A/R		
66		WIRE, " " " , YEL	81-288744			A/R	A/R		
67		WIRE, " " " , ORN	81-288733			A/R	A/R		
68									
69									
70									
71		CABLE TIE	22-117650	PANDUIT	SSTIM	12	12		
72									
73	A1P1	CONNECTOR 7 PIN	51-407148	MOLEX	09-50-7061	1	1		
74		CONNECTOR SOCKET PINS	51-407012	MOLEX		6	6		
75									
76		LOCK WASHER - #6	14-317106			1	1		
77		NUT - #6-32	13-102006			1	1		
78									
79									
80									
81									
82									
83									
84									

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	ADDED C10-D.I.T.	—	2-6-81	



CR3
1N4003
TP7
TP6
4
0-50 VDC
H.S.
R6
51K
1/2 W
Q2
2N6557
R16
12K
1W
CR7
1N914
C6
.1
100V
CR5
1N4976
56V
≈ 100 VDC
J1
12
3
T1
CR1
AR2
F4B
18VAC
H7
13
TP8
+12v
C8, 100pf
200V
Q1
2N6557
VOLTAGE ADJ.
R7
500K
CW
CR6
1N914
R12
510, 1/2 W
2
R13
510
1/2 W
C1
10
150V
R2
51K
R3
51K
C9
100pf
200V
R5
5.1K
C5, 100pf
200V
R17
10K
R10
56K
HELIX
1
GRID
7
CATH
14
R1
68K
U1A
LM339
U1B
TP9
+6V
U1C
U1D
R14
10 M, 3W, 5%
R5
CR2
12V
1N4742
C2
.1
100V
C3
.1
100V
R4
51K
C4
.1
100V
C7
.1
100V
CR4
1N914
R8
51K
R9
51K
C10
D.I.T.
R11
51K
3
TP10
D
C
B
A

DASH NO.	JUMPER TABLE 2		
00	POS GRID	3-2	5-6
01	NEG GRID	1-2	4-5

NOTES:

4 . . VOLTAGE REF TO TB8

3 ALL VOLTAGES REF TO TP10 EXCEPT TP6.

2 SEE JUMPER TABLE

UNLESS OTHERWISE NOTED: ALL RESISTORS 1/4W, COMP., 5%
ALL CAPACITOR ARE IN MICROFARDS

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS	R602	

D135195
NEXT ASSEMBLY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS: 1PL ± .1 2PL ± .02
3PL ± .005
FRAC ± 1 64
ANG ± 1°
SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER
DR 6/21/80
CHK 2-6-81
APPD L. Barnes 2-6-81
APPD 4-6-81
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

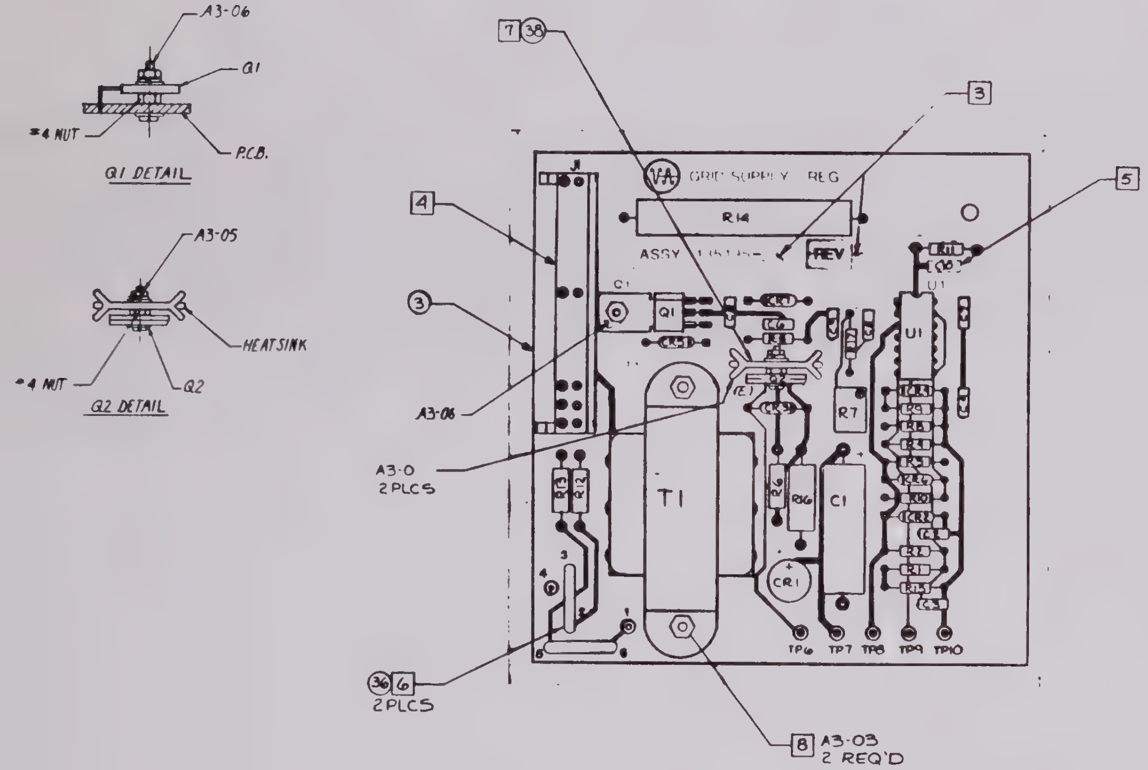
varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA, CALIFORNIA

SCHEMATIC
GRID SUPPLY / REGULATOR

SIZE D
CODE IDENT NO 59782
135192
A
SCALE N/A
SHEET 1 OF 1
SUPERSEDES

135192

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	REVISED	—	1/30/81	JHT
	B	INCORP EO	15243	8-13-81	
	-	INC E.O.	15287	9-4-81	


A3-06
Q1
P.C.B.
#4 NUT
Q1 DETAIL
A3-05
HEATSINK
Q2
#4 NUT
Q2 DETAIL
7 38
3
5
4
3
A3-06
A3-0
2PLCS
36 6
2PLCS
8 A3-03
2 REQ'D
GRID SUPPLY REG
ASSY
REV
R14
Q1
C1
U1
R7
T1
C1
CR1
R16
R13
R12
TP6
TP7
TP8
TP9
TP10

NOTES :
1 ASSEMBLE PER VARIAN WORKMANSHIP STD 87-800299
2 ASSEMBLE USING HARDWARE PER DWG NO 110625.
3 MARK WITH CURRENT ASSY DASH NO. AND REV. LETTER.
4 REMOVE PINS 2,3,4,5 6,8,9,10 & 11.
5 OPTIONAL CAPACITOR . DIT.
6 FOR -00 VERSION JUMPER 3-2, 5-6, FOR-01 JUMPER 1-2, 4-5.
7 APPLY THIN LAYER THERMAL COMPOUND UNDER Q2.
8 HARDWARE FOR SUPPORT DURING STORAGE ONLY.

SEE SEPARATE LIST OF MATERIALS, LM-135195

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
LIST OF MATERIALS				R602

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005
FRAC ± 1/64
ANG ± 1°
SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

NEXT ASSEMBLY | USED ON
APPLICATION

CONTRACT NUMBER
DR L. LAPPIN 7-11-80
CHK 7-15-80
APPD Jude Craik 1-6-81
APPD 5-11-81
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA, CALIFORNIA

ASSEMBLY
GRID SUPPLY/REGULATOR

SIZE D
CODE IDENT NO 59782
135195
C
SCALE 2/1
SHEET OF
SUPERSEDES

SHEET 1 3

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: GRID SUPPLY/REGULATOR	LM 135195 REV C
CODE IDENT NO. 59782	APPROVAL	DATE 5-12-81	

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
			A	REVISED	—	1/30/81	JHT
			B	INCORP E.O.	15243	8-13-81	
			C	INCORP E.D.	15287	9-8-81	

DASH NO.	DESCRIPTION
-00	POSITIVE GRID
-01	NEGATIVE GRID

R602

REVISION STATUS

SHEET	
LTR	
SHEET	
LTR	
SHEET	
LTR	

FORM 1758-01-375

SHEET 2 3

varian
MICROWAVE EQUIPMENT OPERATIONS
GRID SUPPLY/REGULATOR
LM 135195
REV C

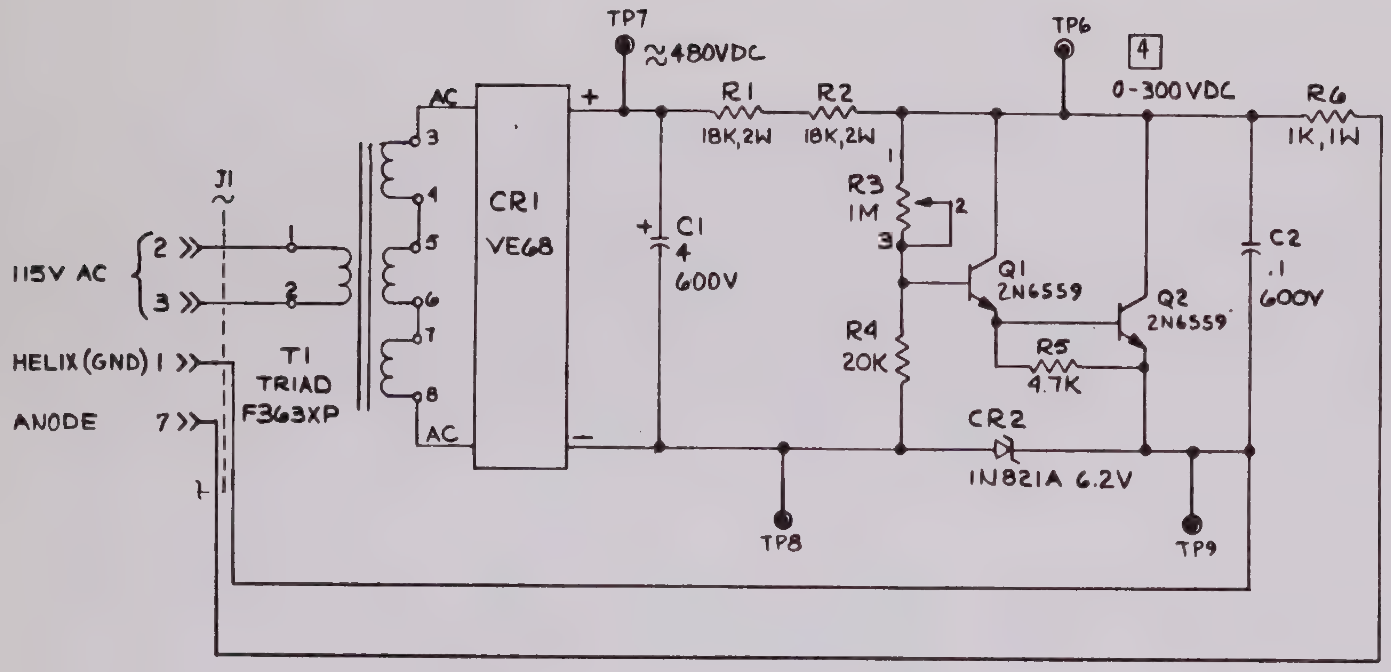
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO	QTY/DASH NO. -00	-01	-02	-03
1		SCHEMATIC	D135192			ref	ref		
2									
3		FABRICATION	D135194			1	1		
4									
5	C1	CAPACITOR, ELECT., 10 µf 150V	41-508805	SPRAGUE	TVA-1406	1	1		
6	C2-4, C6,7	CAPACITOR, CERAMIC, .1 µf 100V	41-229952		CK06BX104K	5	5		
7	C8,9,5	CAPACITOR, CERAMIC, 100 pf 200V	41-229960		CK05BX101K	3	3		
8	C10	CAPACITOR, CERAMIC	D.I.T.		CK06				
9									
10									
11	CR1	RECTIFIER BRIDGE	66-235033	VARO	VE68	1	1		
12	CR2	DIODE, ZENER 12V	66-314742		1N4742	1	1		
13	CR3	DIODE, SIGNAL	66-304003		1N4003	1	1		
14	CR4,6,7	DIODE, SIGNAL	66-320914		1N914B	3	3		
15	CR5	DIODE, ZENER 56V 5W	66-335006		1N4976	1	1		
16	J1	CONNECTOR - 14 SOCKET	51-411012	MOLEX	09-52-3142	1	1		
17	Q1,2	TRANSISTOR, NPN	62-990244		2N6557	2	2		
18									
19	R1	RESISTOR, COMP., 68K 1/4W 5%	32-301568		RC07GF683J	1	1		
20	R2-4, 8,9,11	RESISTOR, COMP., 51K 1/4W 5%	32-301551		RC07GF513J	6	6		
21	R5	RESISTOR, COMP., 5.1K 1/4W 5%	32-301451		RC07GF512J	1	1		

SHEET 3 3

varian	MICROWAVE EQUIPMENT OPERATIONS	GRID SUPPLY/REGULATOR			LM 135195	REV C			
ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO	MFG	MFG OR MS PART NO.	QTY, DASH NO.			
						-00	-01	-02	-03
22	R7	RESISTOR, VARIABLE 500K	36-797766	BOURNS	3292W-1-504	1	1		
23	R10	RESISTOR, COMP., 56K 1/4W 5%	32-301556		RC07GF563J	1	1		
24	R12,13	RESISTOR, COMP., 510Ω 1/2W 5%	32-201351		RC20GF511J	2	2		
25	R14	RESISTOR, THK FILM, 10M 3W 5%	31-600656	PYROFILM	PVC175	1	1		
26	R15	RESISTOR, COMP., 100Ω 1/4W 5%	32-301310		RC07GF101K	1	1		
27	R16	RESISTOR, COMP., 12K 1W 5%	33-301512		RC32GF123J	1	1		
28	R6	RESISTOR, COMP., 51K ½W 5%	32-201551		RC20GF513J	1	1		
29	R17	RESISTOR, COMP., 10K ¼W 5%	32-301510		RC07GF103J	1	1		
30									
31	T1	TRANSFORMER	44-149144	TRIAD	F148XP	1	1		
32									
33	TP6-10	TEST JACK (RED)	51-451861	E.F.JOHNSON	105-0852-001	5	5		
34	U1	VOLTAGE QUAD COMPARITOR	62-600153	NSC	LM339N	1	1		
35									
36	JPR1,2	JUMPER	51-452 939	CAMBION	461-2872-05-03-10	2	2		
37									
38		HEATSINK (Q2)	66-899404	THERMALLOY	6025B	1	1		
39									
40		THERMAL COMPOUND	88-298900	WAKEFIELD	120-8	A/R	A/R		
41									
42									

REVISIONS

ZONE	LTR	DESCRIPTION	EO	DATE	PPROVED
	A	REVISED C1 WAS 400V Q1 & Q2 WIRING CHG	—	2-5-81	



TP7
≈480VDC
TP6
4
0-300VDC
AC
+
−
AC
R1
18K,2W
R2
18K,2W
R6
1K,1W
J1
115V AC
2
3
HELIX (GND) 1
ANODE 7
T1
TRIAD
F363XP
3
4
5
6
7
8
CR1
VE68
C1
4
600V
R3
1M
1
2
3
R4
20K
Q1
2N6559
Q2
2N6559
R5
4.7K
C2
.1
600V
CR2
1N821A 6.2V
TP8
TP9

NOTES: 1. ALL RESISTOR VALUES ARE IN OHMS 1/4W 5% COMP.

2. ALL CAPACITOR VALUES ARE IN MICRO-FARADS.

3 ALL VOLTAGES REF TP8 EXCEPT TP6

4 TP6 VOTAGE REF TP9

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS	R602	

NEXT ASSEMBLY	USED ON
D135197	E135216

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS: 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO.
FINISH

CONTRACT NUMBER
DR L.LAPPIN ~~7-18-80~~
CHK J.J.Day 2-5-81
APPD 2-6-81
APPD 5-11-81
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

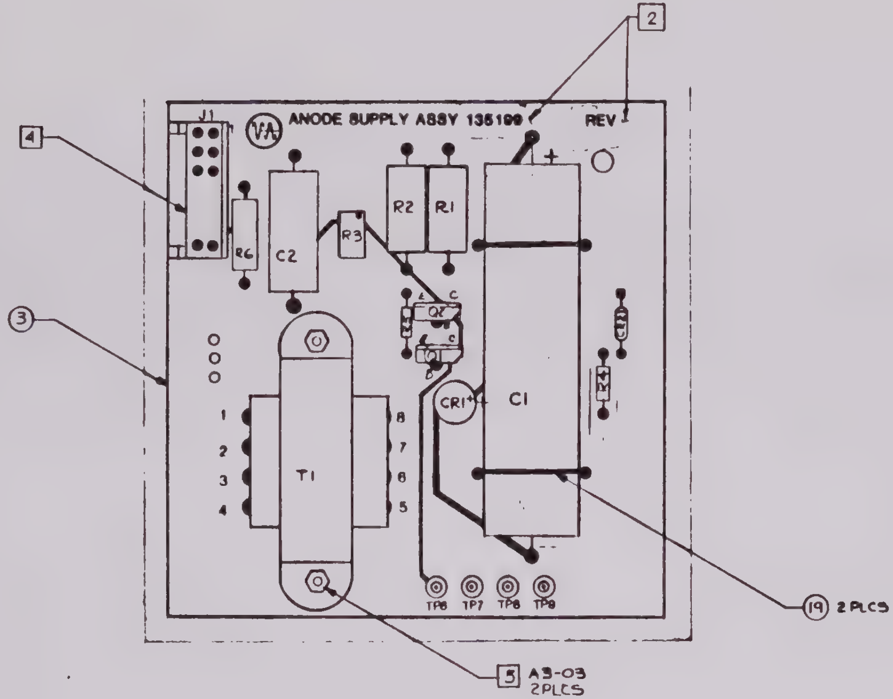
varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA, CALIFORNIA

SCHEMATIC
ANODE SUPPLY

SIZE C
CODE IDENT NO. 59782
135196
A
SCALE NONE
SHEET 1 OF 1
SUPERSEDES

REVISIONS

ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	REVISED	–	1/29/81	JHT
	B	INCORP EO	15259	9 13 81	



2
4
3
J1
ANODE SUPPLY ASSY 135199
REV
+
R6
C2
R3
R2
R1
Q2
Q1
CR1
C1
T1
1
2
3
4
8
7
6
5
TP6
TP7
TP8
TP9
19 2 PLCS
5 AS-03 2PLCS

5 HARDWARE FOR SUPPORT DURING STORAGE.
4 REMOVE PINS 4,5, AND 6.
3 ASSEMBLE USING HARDWARE PER DWG NO. 110625.
2 MARK WITH CURRENT DASH NO. & REVISION LETTER OF ASSY.
1 ASSEMBLE PER VARIAN WORKMANSHIP STD 87-800299.
NOTES: UNLESS OTHERWISE SPECIFIED

SEE SEPARATE LIST OF MATERIALS-LM135199

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM

LIST OF MATERIALS R602

NEXT ASSEMBLY	USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1°
SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER

DR	L LAPPIN	7-14-80
CHK	J Day	2-5-81
APPD	L Banks	5-11-81
APPD		5-11-81

DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA, CALIFORNIA

ASSEMBLY
ANODE SUPPLY

SIZE D CODE IDENT NO 59782 135199 B
SCALE 2/1 SHEET OF
SUPERSEDES

D 135199

SHEET 1 2

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE: ANODE SUPPLY	LM 135199
CODE IDENT NO. 59782	APPROVAL	DATE 5-11-81	REV B

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
			A	REVISED	—	1/22/82	JWB JHT
			B	INCORP E.O.	15259	8-13-81	

R602

REVISION STATUS

SHEET																											
LTR																											
SHEET																											
LTR																											
SHEET																											
LTR																											

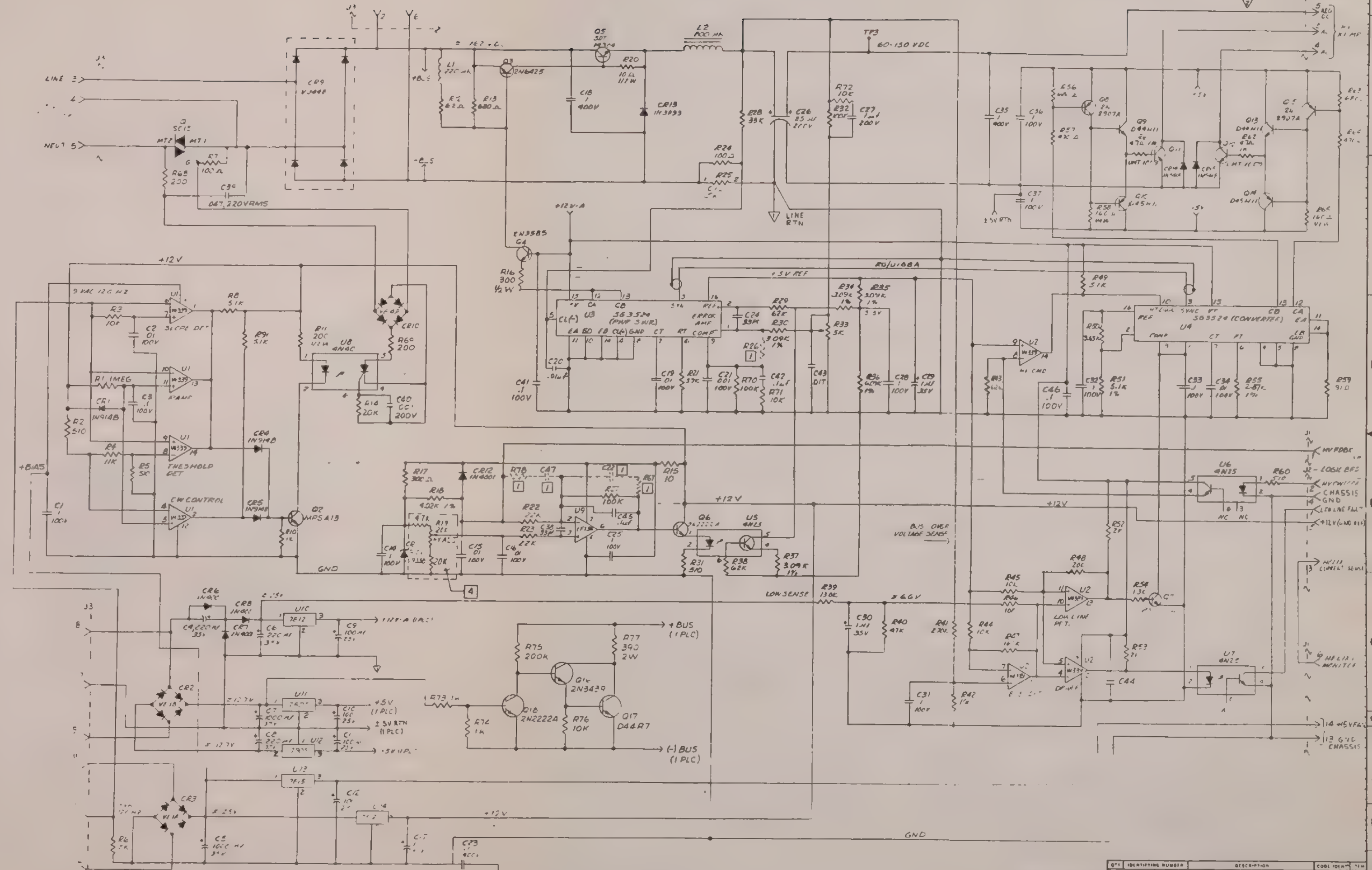
FORM 1758-01-375

SHEET 2 OF

varian	MICROWAVE EQUIPMENT OPERATIONS	ANODE SUPPLY	LM 135199	REV B

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
1		SCHEMATIC	C135196			ref			
2									
3		FABRICATION	D135198			1			
4									
5	C1	CAPACITOR, 4 μf 600V	41-508893	SPRAGUE	TVA1960	1			
6	C2	CAPACITOR, .1 μf 600V	41-718813	SPRAGUE	#431P10496	1			
7									
8	CR1	DIODE, BRIDGE	66-235033	VARO	VE68	1			
9	CR2	DIODE, ZENER, 6.2V	66-310821		1N821A	1			
10	J1	CONNECTOR, 7 CIRCUIT	51-411011	MOLEX	09-52-3072	1			
11	Q1,2	TRANSISTOR, NPN	62-990245		2N6559	2			
12									
13	R1,2	RESISTOR, C.C., 18K 2W 5%	34-402518		RC42GF183K	2			
14	R3	POTENTIOMETER 1M	36-797538	BOURNS	3292W-1-105	1			
15	R4	RESISTOR, C.C., 20K 1/4W 5%	32-301520		RC07GF203J	1			
16	R5	RESISTOR, C.C., 4.7K 1/4W 5%	32-301447		RC07GF472J	1			
17	R6	RESISTOR, C.C., 1K 1W 5%	33-307410		RC32GF102J	1			
18									
19		CABLE TIE, (C1)	22-119653			2			
20	T1	TRANSFORMER	44-149143	TRIAD	F363XP	1			
21	TP6-9	TEST JACK (RED)	51-U51861	EF JOHNSON	105-0852-001	4			

ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	REVISED		2063	
	B	REVISED		6 .16	
	C	INCORP EO 15271	15247		
	D	INC EO	15409	10 19 81	KX/JP
	E	INC EO	15743	3 8 82	JS


LINE 3
4
NEUT 5
J1
J2
J3
SC15
MT2
MT1
R7 100 Ω
R68 200
C39 .047, 220VRMS
CR9 VJ448
L1
R12 82 Ω
R13 680 Ω
Q3 2N6425
Q5
R20 10 Ω 1/2 W
C18 1 400V
CR13 1N3893
L2 700 µH
TP3 60-150 VDC
R28 39K
C26
R72 10K
R32
C27 1 µf 200V
R24 100 Ω
R25
LINE RTN
+12V-A
2N3585 Q4
R16 300 1/2 W
+12V
9 VAC 120 HZ
U1 SLOPE DET
R3 10K
C2 .01 100V
R8 5.1K
R9 5.1K
R11 200 1/2 W
U8 4N40
CR10
R60 200
R1 1MEG
CR1 1N914B
C3 .1 100V
U1 RAMP
R2 510
R4 11K
R5 5K
U1 THRESHOLD DET
CR4 1N914B
CW CONTROL U1
CR5 1N914B
Q2 MPSA13
R10 1K
+BIAS
C1 1 100V
R18 20K
C40 .001 200V
GND
U3 SG3524 (PWM SWR)
ERROR AMP
C41 .1 100V
C20 .01 µF
C19 .01 100V
R21 3.3K
C21 .001 100V
R70 100K
C42 .1 µF
R71 10K
C43
R34
R35
R33 5K
R26
C24
R29
R30 309K 1%
R36
C28 .1 100V
C29 1 µf 35V
+5V REF
SG/U188A
R49 5.1K
U4 SG3524 (CONVERTER)
R50
R51 5.1K 1%
C32 .1 100V
U2
R43
C46 .1 100V
C33 .1 100V
C34 .01 100V
R55 2.87K 1%
R59 910
C35 1 400V
C36 .1 100V
R56
R57
Q8 2N2907A
Q9 D44H11
Q11
Q13 D44H11
Q7 2N2907A
C37 .1 100V
R58
Q10 D45H11
Q14 D45H11
+5V RTN
-5V
R17 300 Ω
CR12 1N4001
R78
C47
C22
R15 10
R18 4.02K 1%
R22
R23 22K
C38
U9 LF13
C45 .1 µF
C25 .1 100V
C15 .01 100V
C16 .01 100V
R19 22K
C49 100V
20K
Q6
U5 4N25
+12V
R31 510
R38 62K
R37 3.09K 1%
LOW SENSE
R39 13.0K
+6.6V
C30 1 µf 35V
R40 47K
R41 27K
R44 10K
R45 10K
R46 10K
R48 20K
U2 LOW LINE DET.
R52 2K
R54 13K
R53
U2
C44
C31 1 100V
R42
U6 4N35
R60 510
U7 4N25
HV FDBK
LOGIC BPS
HV ON/OFF
CHASSIS GND
+12V (LNO 010)
CURRENT SENSE
HELIX MONITOR
14 +5V FAIL
13 GND CHASSIS
BUS OVER VOLTAGE SENSE
CR6 1N4001
CR8 1N4001
U10 7812
C9 100 µf 25V
+12V-A UNREG
C4 220 µf 35V
CR7 1N4001
C6 220 µf 35V
+BUS (1 PLC)
R77 390 2W
R75 200K
Q16 2N3439
CR2 VE18
U11
+5V (1 PLC)
±5V RTN (1 PLC)
C7
C8
U12
-5V UNREG
R73 1K
R74 1K
Q18 2N2222A
R76 10K
Q17 D44R7
(-) BUS (1 PLC)
U13 7815
CR3 VE18
C12
+12V
U14
C5 1000 µf 35V
R6
C23
GND
4

4. RESISTOR NETWORK USE ONLY ON PCB MARK TM1028-114
3. ALL CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.
1 THESE COMPONENTS ARE USED FOR SPECIAL APPLICATIONS ONLY
NOTES. UNLESS OTHERWISE SPECIFIED

REF DES TABLE	
LAST USED	UNUSED
C47	C13
CR15	
J3	
L2	
Q18	
R78	R66
U14	

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS		

E135215
NEXT ASSEMBLY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS
FRAC ± 1/64
ANGLE ± 1°
SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

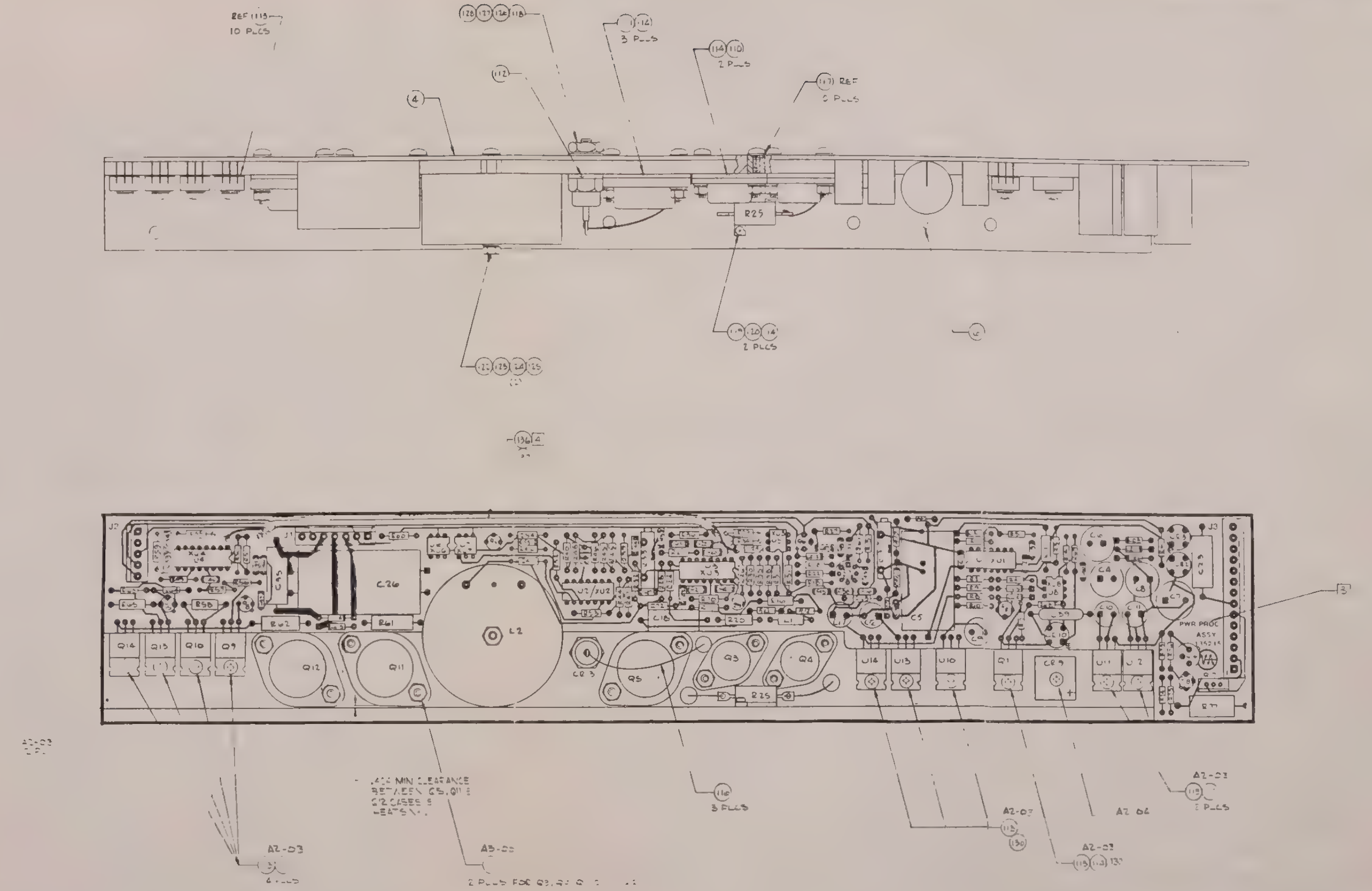
CONTRACT NUMBER
DR 2 13 80
CHK 2-6-81
APPD 2-6-81
APPD
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATION
SANTA CLARA, CALIFORNIA

SCHEMATIC,
POWER PROCESSOR PCB

SIZE	CODE IDENT NO		
E	59782	135212	E

SCALE | SHEET 1 OF 1
SUPERSEDES


REF 113
10 PLCS
128 127 126 118
111 114
3 PLCS
114 110
2 PLCS
112
117 REF
2 PLCS
4
R25
119 120 14
2 PLCS
122 123 124 125
136 4
J2
J1
J3
C26
C45
L2
R61
R62
R58
CR3
Q14
Q13
Q10
Q9
Q12
Q11
Q5
Q3
Q4
R25
U14
U13
U10
Q1
CR9
U11
U12
C4
C6
C7
C8
C10
C11
C5
C18
PWR PROC ASSY
3
.438 MIN CLEARANCE BETWEEN Q5, Q11 & Q12 CASES & HEATSINK
A2-03
4 PLCS
A3-03
2 PLCS FOR Q3, Q4
116
3 PLCS
A2-03
115
130
A2-03
115 113 130
A2 04
A2-03
115
2 PLCS

4 ASSEMBLE CABLE ASSY ITEM(S) BELOW TOP OF PC BOARD AT THE FAR... AS SHOWN. ... WITH EPOXY ITEM 1?

3 MARK WITH DASH NO & CURRENT REVISION LETTER OF ASSY

2. ASSEMBLE USING HARDWARE DRAWING 110625

1. ASSEMBLE PER VARIAN WORKMANSHIP STANDARD 87-800-200

5 PHANTOMED COMPONENTS ARE USED FOR SPECIAL APPLICATIONS ONLY.

NOTES

SEE SEPARATE LIST OF MATERIAL

varian

MOST

ASSEMBLY
PWR PROCESSOR PCB

1352

E 50782 1352 E F

SHEET 1 8

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE. POWER PROCESSOR PCB ASSY	LM 135215	REV F
CODE IDENT NO 59782	APPROVAL	DATE June [illegible] 4/29/81	R613	

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
135216			A	REVISED	—	2/2/81	JHT / LWB
			B	INCORP E.O. 15271, 15245	—	8-13-81	
			C	UPDATE REV LTR 15247	15363	9-19-81	AL/ JR
			D	INC. E.O. (SHEET 2 ONLY)	15271	10-8-81	KK/ J.A.
			E	INC. EO.	15496	11-30-81	JS/KK
			F	INC EO's	15743	3-11-82	JS/ J.A.

1 THESE COMPONENTS ARE USED FOR SPECIAL APPLICATIONS ONLY.

REVISION STATUS

SHEET																											
LTR																											
SHEET																											
LTR																											
SHEET																											
LTR																											

FORM 1758-01-375

SHEET 2

varian	MICROWAVE EQUIPMENT OPERATIONS	POWER PROCESSOR PCB ASSY	LM 135215	REV F

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO.			
						-00	-01	-02	-03
1		SCHEMATIC	E135212			ref			
2									
3									
4		FABRICATION	E135214			1			
5									
6		HEATSINK	D135217			1			
7	C39	CAPACITOR, FILM, .047μF, 220V	41-749998	SPRAGUE	439P4730220	1			
8	C1,3,14,25 28,31-33	CAPACITOR, CERAMIC, .1 μf 100V	41-229952		CK06BX104K	15			
	36,37,41,42, 44-46								
9	C21,40	CAPACITOR, CERAMIC,.001 μf 200V	41-229953		CK06BX102K	2			
10	C2,15,16 19,34,20	CAPACITOR, CERAMIC, .01 μf 100V	41-229963		CK05BX103K	6			
11	C4,6,8	CAPACITOR, ELECT., 220 μf 35V	41-503904	SPRAGUE	503D227F035PE	3			
12	C5	CAPACITOR, ELECT., 1000 μf 40V	41-505891	SIEMENS	B41010-1000/40/ 82000	1			
13	C9,12,17	CAPACITOR, ELECT., 100 μf 25V	41-503905	SPRAGUE	503D107F025NC	3			
14	C10,11	CAPACITOR, ELECT., 100 μf 20V	41-503903	SPRAGUE	672D107H020CG5C	2			
15	C30,29,	CAPACITOR, TANT., 1 μf 50V	41-609459	SPRAGUE	196D105X9050HA1	2			
16	C18,23, 35	CAPACITOR, W&F .1 μf 400V	41-749981	SIEMENS	B32231.1/ 20400/ 5200	3			
17									
18	C24,38	CAPACITOR, CERAMIC 33 pf 200V	41-234195		CK05BX330K	2			
19	C26	CAPACITOR, EXTRA-LYTIC 85 μf 200V	41-503902	SPRAGUE	604D850F200HJ6	1			
20	C27	CAPACITOR, CERAMIC, .1 μf 200V	41-238950	ERIE	8131-200-254-104M	1			

SHEET 3 8

varian	MICROWAVE EQUIPMENT OPERATIONS	POWER PROCESSOR PCB ASSY	LM 135215	REV F

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
21	C7	CAPACITOR, ELECT, 1000 μF, 16V	41-503908	SPRAGUE	503D108F016QE	1			
22	C22, 43, 47	CAPACITOR, CERAMIC	$\boxed{1}$			3			
23	CR1,4,5	DIODE, SIGNAL	66-320914		1N914B	3			
24	CR2,3	BRIDGE	66-235013	VARO	VE-18	2			
25	CR6-8, 12	DIODE, RECTIFIER	66-304001		1N4001	4			
26	CR9	BRIDGE, 10 AMP	66-235036	VARO	VJ-448	1			
27	CR10	BRIDGE, 1 AMP	66-235031	VARO	VE-48	1			
28	CR11	DIODE, ZENER	66-310935		1N935A	1			
29	CR13	DIODE, RECTIFIER	66-303893		1N3893	1			
30	CR14,15	DIODE, RECTIFIER	66-332013		1N5418 JAN	2			
31	J1	CONNECTOR, 7 PIN	51-407101	MOLEX	09-72-1071	1			
32	J2	CONNECTOR, 5 PIN	51-407019	MOLEX	09-65-1051	1			
33	J3	CONNECTOR, 14 PIN	51-411010	MOLEX	09-65-1141	1			
34	L1	INDUCTOR, 220 μh	43-299918	NYTRONICS	WEE-220	1			
35	L2	INDUCTOR, 800 μh	43-111850	SPRAGUE	46ZP008S0800	1			
36									
37									
38	Q1	THYRISTOR, TRIAC, 400V	66-650002	G.E.	SC151D	1			
39	Q6,7,18	TRANSISTOR, NPN	62-912222		2N2222A	3			
40	Q3	TRANSISTOR ,PNP SWITCH	62-906425		2N6425	1			
41	Q4	TRANSISTOR, NPN	62-903585		2N3585	1			

SHEET 4 8

varian	MICROWAVE EQUIPMENT OPERATIONS	POWER PROCESSOR PCB ASSY			LM 135215	REV F			
ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
42	Q5	TRANSISTOR, NPN	62-989814	SOLITRON DEVICES	SDT14304	1			
43	Q8,15	TRANSISTOR, PNP	62-912907		2N2907A	2			
44	Q9,13	TRANSISTOR, NPN	62-798003	GEN. ELEC.	D44H11	2			
45	Q10,14	TRANSISTOR, PNP	62-798008	GEN. ELEC.	D45H11	2			
46	Q11,12	TRANSISTOR, NPN	62-990171	UNITRODE	UMT1009	2			
47	Q2	TRANSISTOR, NPN	62-920023	MOTOROLA	MPSA13	1			
48	Q16	TRANSISTOR, NPN	62-903439		2N3439	1			
49	Q17	TRANSISTOR, NPN	62-798026	G.E.	D44R7	1			
50	R1	RESISTOR, COMP., 1MΩ 1/4W 5%	32-301710		RC07GF105J	1			
51	R2,5,31,60	RESISTOR, COMP., 510Ω 1/4W 5%	32-301351		RC07GF511J	4			
52	R3,42,44,45,46,71,72,76	RESISTOR, COMP., 10KΩ 1/4W 5%	32-301510		RC07GF103J	8			
53	R4,	RESISTOR, COMP., 11KΩ 1/4W 5%	32-301511		RC07GF113J	1			
54	R6,52,53	RESISTOR, COMP., 2KΩ 1/4W 5%	32-301420		RC07GF202J	3			
55	R7	RESISTOR, COMP., 100Ω 1/4W 5%	32-301310		RC07GF101J	1			
56	R8,9,49	RESISTOR, COMP., 5.1KΩ 1/4W 5%	32-301451		RC07GF512J	3			
57	R10,73,74	RESISTOR, COMP., 1KΩ 1/4W 5%	32-301410		RC07GF102J	3			
58	R11	RESISTOR, COMP., 200Ω 1/2W 5%	32-201320		RC20GF201J	1			
59	R12	RESISTOR, COMP., 62Ω 1/4W 5%	32-301262		RC07GF620J	1			
60	R13,56,63	RESISTOR, COMP., 680Ω 1/4W 5%	32-301368		RC07GF681J	3			
61	R16	RESISTOR, COMP., 300Ω 1/2W 5%	32-201330		RC20GF301J	1			
62	R17	RESISTOR, COMP., 300Ω 1/4W 5%	32-301330		RC07GF301J	1			

SHEET 5 8

varian	MICROWAVE EQUIPMENT OPERATIONS	POWER PROCESSOR PCB ASSY	LM 135215	REV F

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
63	R36	RESISTOR, M.F., 6.04KΩ 1/8W 1%	31-224604		RN55	1			
64	R19	RESISTOR, VAR., 20KΩ 3/4W 10%	36-792212	BOURNS	3006P-1-203	1			
65	R20	RESISTOR, COMP., 10Ω 1/2W 5%	32-201210		RC20GF100J	1			
66	R21	RESISTOR, COMP., 3.9K 1/4W 5%	32-301439		RC07GF392J	1			
67	R22,23	RESISTOR, COMP., 22KΩ 1/4W 5%	32-301522		RC07GF223J	2			
68	R24	RESISTOR, COMP., 100Ω 1/4W 5%	32-301310		RC07GF101J	1			
69	R25	RESISTOR, W.W., 0.1Ω 5W	31-575107	DALE	RH-5 SERIES	1			
70	R28	RESISTOR, COMP, 33 K, 1/4W, 5%	32-301 533		RC07GF333J	1			
71	R55	RESISTOR, M.F., 2.87K, 1/4W, 1%	31-224-287	DALE	CMF-55-T1	1			
72	R40	RESISTOR, COMP., 47KΩ 1/4W 5%	32-301547		RC07GF473J				
73	R29,38, 43	RESISTOR, COMP., 62KΩ 1/4W 5%	32-301562		RC07GF623J	3			
74	R30,34, 35,37	RESISTOR, M.F. 3.09KΩ 1/8W 1%	31-224309		RN55	4			
75	R32,27,70	RESISTOR, COMP., 100KΩ 1/4W 5%	32-301610		RC07GF104J	3			
76	R33	RESISTOR, VARIABLE 5KΩ 3/4W 10%	36-792218	BOURNS	3006P-1-502	1			
77	R39	RESISTOR, COMP., 130KΩ 1/4W 5%	32-301613		RC07GF134J	1			
78	R41	RESISTOR, COMP., 270KΩ 1/4W 5%	32-301627		RC07GF274J	1			
79	R47	RESISTOR, COMP., 160KΩ 1/4W 5%	32-301616		RC07GF164J	1			
80	R48,14	RESISTOR, COMP., 20KΩ 1/4W 5%	32-301520		RC07GF203J	2			
81	R79	RESISTOR COMP 20K 1/8W				1			
82	R54	RESISTOR, COMP., 1.3KΩ 1/4W 5%	32-301413		RC07GF132J	1			
83	R50	RESISTOR, M.F., 3.65KΩ 1/4W,1%	31-604365			1			

SHEET 6 (X)

varian	MICROWAVE EQUIPMENT OPERATIONS	POWER PROCESSOR PCB ASSY	LM 135215	REV F

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
84	R57,64	RESISTOR, COMP., 470Ω 1/4W 5%	32-301347		RC07GF471J	2			
85	R58,65	RESISTOR, COMP., 160Ω 1/2W 5%	32-201316		RC20GF161J	2			
86	R59	RESISTOR, COMP., 91Ω 1/4W 5%	32-301291		RC07GF910J	1			
87	R61,62	RESISTOR, COMP., 4.7Ω 2W 10%	35-199129		IRC BWH	2			
88	R68,69	RESISTOR, COMP., 200Ω, 1/4W 5%	32-301320		RC07GF201J	2			
89	R15	RESISTOR, COMP., 10Ω 1/4W 5%	32-301210		RC07GF100J	1			
90	R77	RESISTOR, COMP., 390Ω, 2W, 5%	34-401339		RC42GF391J	1			
91	R75	RESISTOR, COMP., 200K, 1/4W, 5%	32-301620		RC07GF204J	1			
92	R26, 67, 78	RESISTOR, COMP.,	$\boxed{1}$	DALE	CMF-55-T1	3			
93	R51	RESISTOR, M.F., 5.1K, 1%, 1/8W	31-224-511			1			
94	R18	RESISTOR M.F. 4.02K, 1%, 1/4W	31-224402			1			
95	U1,U2	I.C.-QUAD COMPARATOR	62-601270	NATIONAL SEMI-CONDUCTOR	LM339AN	2			
96	U3,U4	I.C.-REGULATOR, PWM	62-601264	SILICON GEN	SG3524N	2			
97	U5-U7	I.C.-OPTO ISOLATOR	66-599720		4N25	3			
98	U8	I.C.-OPTO SCR	66-599722		4N40	1			
99	U9	I.C.-OP AMPL, FET	62-600963	NATIONAL SEMI-CONDUCTOR	LF-156H	1			
100	U12	I.C.-REGULATOR, -5 VOLT	62-600482	MOTOROLA	MC7905CT	1			
101	U10, U14	I.C.-REGULATOR, +12 VOLT	62-600495	MOTOROLA	MC7812CT	2			
102	U11	I.C.-REGULATOR, +5 VOLT	62-600497	MOTOROLA	MC7805CT	1			
103	U13	I.C.-REGULATOR, +15VDC	62-600496	MOTOROLA	MC7815CT	1			
104									

SHEET 7

varian	MICROWAVE EQUIPMENT OPERATIONS	POWER PROCESSOR PCB ASSY	LM 135215	REV F

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO.			
						-00	-01	-02	-03
103									
104	XU3,XU4	SOCKET, I.C., 16 PIN	54-634008	CIRCUIT ASSY	SAE #1 SW3800-16-B-W	2			
105	XU5-XU8	SOCKET, I.C., 6 PIN	54-910329	ROBINSON-NUGENT	ICN-063-S3-G	4			
106	XU1,XU2	SOCKET I.C. 14 PINS	54-634 007		SAE #1-SW 3800-14-BW	2			
107	XU9	SOCKET, 8 PIN	54-634106	AUGAT	8058-3964	1			
108									
109									
110		INSULATOR, TO-66	62-898003	UNION CARBIDE	H-4004	2			
111		INSULATOR, TO-3	62-898002	UNION CARBIDE	H-4001	3			
112		INSULATOR, DO-4	62-898000	UNION CARBIDE	H-4027	1			
113		INSULATOR, PLASTIC	62-899654	THERMALLOY	43-77-2	10			
114		THERMAL COMPOUND	88-298900	WAKEFIELD	#120-8	AR			
115									
116		WIRE,"EE",TEFLON INSUL.#20 WHT	81-288834			AR			
117		BUSHING	22-420036	AMATOM	9223-N-115	10			
118		BUSHING	22-420037	AMATOM	9284-N-194	1			
119		SCREW, PAN HD. #2-56 x 1/4	12-222002-04			2			
120		WASHER, LOCK, INTERNAL TOOTH	14-301102			2			
121									
122		SCREW, PAN HD. #4-40 x 1-1/2	12-222004-24			1			
123		NUT, #4-40	13-102004			1			

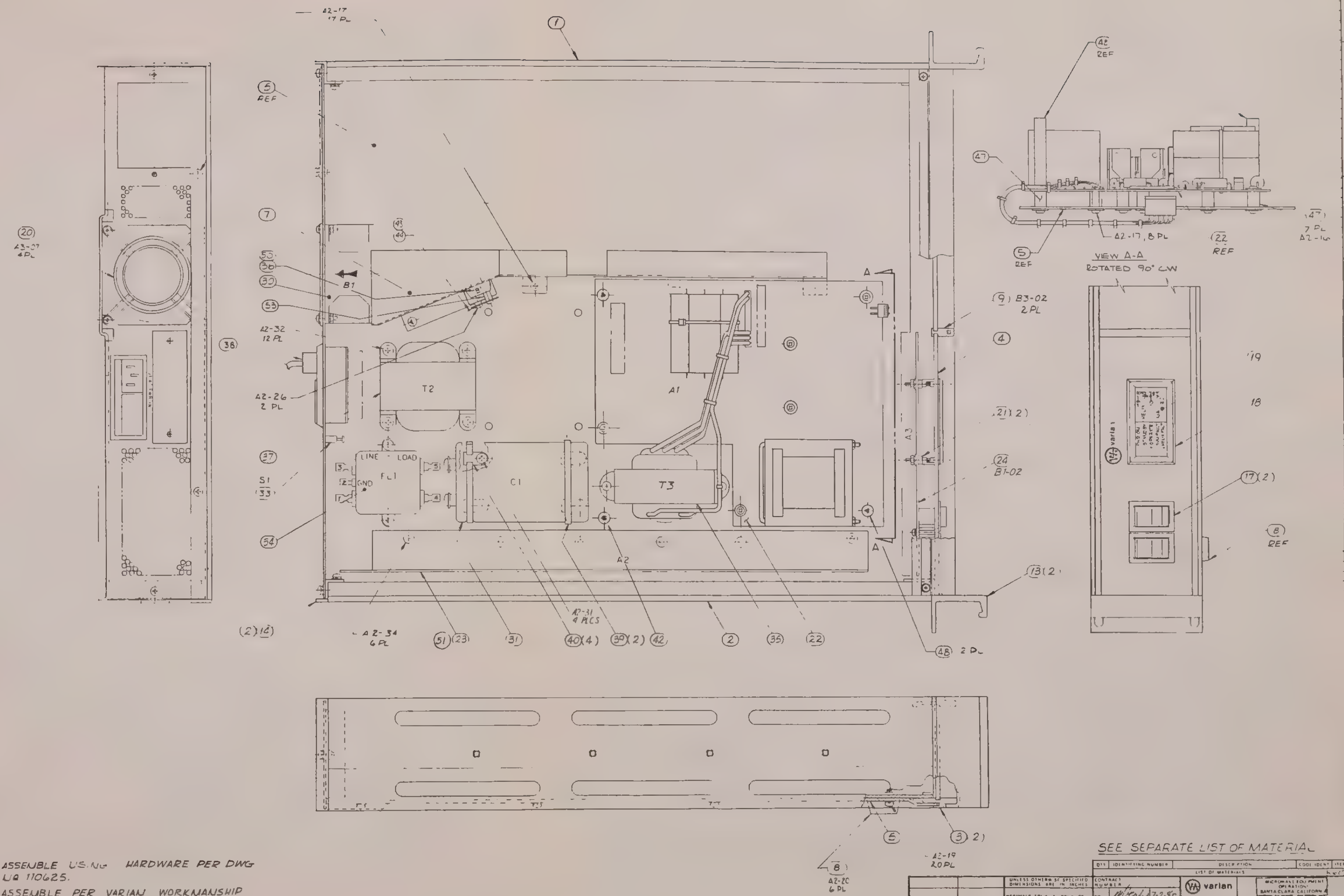
SHEET 8 8

varian	MICROWAVE EQUIPMENT OPERATIONS	POWER PROCESSOR PCB ASSY	LM 135215	REV F

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO.			
						-00	-01	-02	-03
124		WASHER, FLAT, #4	14-122004			2			
125		WASHER, LOCK, #4	14-202004			1			
126		NUT, #10-32	13-102061			1			
127		WASHER, FLAT, #10	14-122010			1			
128		WASHER, LOCK, #10	14-202010			1			
129		WASHER, FLAT, NYLON, #4	14-999702			1			
130		WASHER, INSULATION	62-991000	RCA OR EQUIV.	DF 137A	10			
131									
132									
133									
134									
135									
136		CABLE ASSY	01000111			1			
137		EPOXY	88-199918	TRABOND	2112	A/R			
138									
139									
140									
141									
142									
143									
144									

FORM 1758 02 3/75

	LTR	DESCRIPTION		DATE	APPROVED
	A	REVISED PER E.O.	–	[illegible]	
	[illegible]	[illegible]			



A2-17
17 PL
①
⑤ REF
⑦
(43)
(44)
(50)
(36)
(30)
(53)
B1
A2-32
12 PL
(38)
(20)
A3-07
4 PL
A2-26
2 PL
T2
A1
T3
C1
LINE
LOAD
FL1
GND
A2
A3
(37)
S1
(33)
(54)
(2) 12
A2-34
6 PL
(51) (23)
(31)
A2-31
4 PLCS
(40) (4)
(39) (2)
(42)
②
(35)
(22)
(48) 2 PL
(13) (2)
(9) B3-02
2 PL
④
(21) (2)
(24)
B1-02
(A2) REF
(47)
A2-17, 8 PL
(47)
7 PL
A2-16
⑤ REF
(22) REF
VIEW A-A
ROTATED 90° CW
19
18
varian
(17) (2)
⑧ REF
A
A
⑤
③ 2)
A2-19
20 PL
⑧
A2-20
6 PL

SEE SEPARATE LIST OF MATERIAL

4 ASSEMBLE USING HARDWARE PER DWG UQ 110625.

3 ASSEMBLE PER VARIAN WORKMANSHIP STANDARDS 87-800299.

2 REFERENCE DESIGNATIONS ARE FOR REFERENCE ONLY AND MAY OR MAY NOT APPEAR ON PART

1 SOLDER PER MIL-STD-454, REQUIREMENT 5

NOTES: UNLESS OTHERWISE SPECIFIED

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		LIST OF MATERIALS		

MULTI-USE	MULTI-USE
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER
DR 7-2-80
CHK
APPD 6-16-81
APPD 6/4/81
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATION
SANTA CLARA CALIFORNIA

ASSEMBLY
POWER SUPPLY
3.5" RACK MOUNT

SIZE E CODE IDENT NO 59782 135216

SCALE 1/1 SHEET 1 OF 1

SUPERSEDES

SHEET 1 OF 4

varian	MICROWAVE EQUIPMENT OPERATIONS	TITLE SERIES "K" 3-1/2" POWER SUPPLY	LM 135216	REV B
CODE IDENT NO. 59782	APPROVAL	DATE 6-16-81	June Orrido

APPLICATION			REVISION				
NEXT ASSEMBLY	USED ON	EO	REV	DESCRIPTION	EO	DATE	APPROVED
			A	REVISED	-	2/10/81	JF DAY
			B	INCORP. E.O.	15265	9/11/81	RY/

REVISION STATUS

R627

SHEET																											
LTR																											
SHEET																											
LTR																											
SHEET																											
LTR																											

4240-22-01 6/80

SHEET 2 4

varian	MICROWAVE EQUIPMENT OPERATIONS	SERIES "K" 3-1/2" POWER SUPPLY	LM 135216	REV B

ITEM NO	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO.			
						-00	-01	-02	-03
1		SIDE PANEL, MOD. RT.	112871-00			1			
2		SIDE PANEL, MOD. LT.	129507-01			1			
3		EXTRUSION, MOD.	B133039-05			2			
4		FRONT PANEL, LEFT	C135200-00			1			
5		BASEPLATE	E135201-00			1			
6									
7		SHROULD, AIR DUCTING	135203-00			1			
8		FEET & BAIL ASSY	113808-48			1			
9		SUPPORT, FRONT PANEL	134437-01			1			
10		SCHEMATIC DIAGRAM	135228			ref			
11		OUTLINE DRAWING	D135223			ref			
12									
13		HANDLE	113808-22			2			
14		REAR TRIM	113808-13			2			
15									
16									
17		BEZEL, ROCKER SWITCH	B01000015			2			
18		BEZEL, DISPLAY	76-999953	IEE	DMH23441K-04	1			
19		LENS, DISPLAY	135191-00			1			
20		FINGER GUARD	20-839826	PAMOTOR	5508	1			
21		SPACER, .25 LONG	22-429900	AMATOM	8102-B-0440-3A	2			

SHEET 3 4-

varian	MICROWAVE EQUIPMENT OPERATIONS	SERIES "K" 3-1/2" POWER SUPPLY	LM 135216	REV B

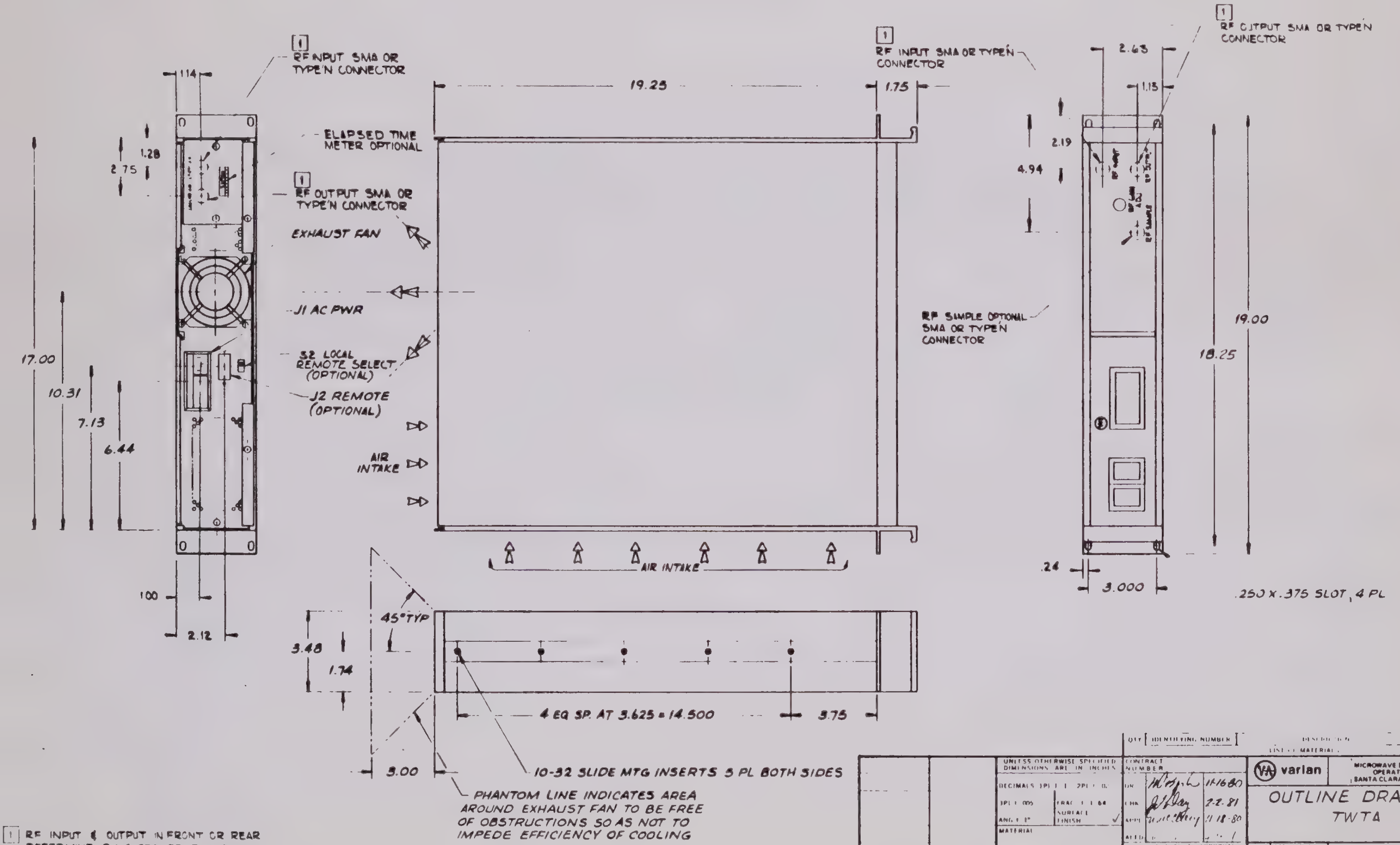
ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
22	A1	HIGH VOLTAGE PCB	135190-00			1			
23	A2	PWR PROCESSOR PCB	135215-00			1			
24	A3	LOGIC PCB	135018-00			1			
25	A4	PROGRAMMED CONN PCB	C135221-00			1			
26									
27									
28									
29	F1	FUSE, 6.25 AMP. SLOBLO	67-135462	LITTLEFUSE	L-3136.25	1			
30	B1	FAN, 12V	20-840200	PAMOTOR	8112	1			
31	C1	CAPACITOR, 3400 µF, 200V	41-536990	SPRAGUE	36DX342F200CC2A	1			
32									
33	S1	SWITCH, INTERLOCK	71-219969	GRAYHILL	30-15	1			
34	FL1	FILTER, INPUT	43-399884	CDE	APF1050L	1			
35	T3	TRANSFORMER, FIL.	C135185-00			1			
36	TB1	TERMINAL BLOCK	56-198993	KULKA		1			
37	T2	TRANSFORMER, BIAS	44-149142	(SIGNAL)	DL36-1	1			
38									
39		CABLE TIE	22-119713	PANDUIT	PRT3S	2			
40		MOUNT, CABLE TIE	22-119604	PANDUIT	TA1S8	4			
41									
42		SPACER, STAND-OFF	135187-00			1			

FORM 1758 02 375

varian | MICROWAVE EQUIPMENT OPERATIONS | SERIES "K" 3-1/2 POWER SUPPLY | LM 135210 | REV B

ITEM NO.	REF DES	DESCRIPTION	VARIAN PART NO.	MFG	MFG OR MS PART NO.	QTY/DASH NO. -00	-01	-02	-03
43		QUICK DISCONNECT	56-199757			3			
44		QUICK DISCONNECT	56-199758			3			
45									
46									
47		STAND-OFF	C135187-01			7			
48		STAND-OFF	C135187-04			2			
49									
50		MARKER STRIP, TB1	56-999309	KULKA		1			
51		THERMAL COMPOUND	88-298900	WAKEFIELD	120-8	A/R			
52									
53		SPACER	22-419841	AMATOM	9226-A-140-0	2			
54									
55		WIRE LIST & WIRE RUN ASSY	D135210			ref			
56									
57									
58									
59									
60									
61									
62									
63									

ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	ADDED RF INPUT & OUTPUT INFO		3/18/81	



1 RF INPUT SMA OR TYPE N CONNECTOR
1.14
1.28
2.75
ELAPSED TIME METER OPTIONAL
1 RF OUTPUT SMA OR TYPE N CONNECTOR
EXHAUST FAN
J1 AC PWR
J2 LOCAL REMOTE SELECT (OPTIONAL)
J2 REMOTE (OPTIONAL)
AIR INTAKE
17.00
10.31
7.13
6.44
1.00
2.12
19.25
1.75
1 RF INPUT SMA OR TYPE N CONNECTOR
AIR INTAKE
45° TYP
3.48
1.74
3.00
4 EQ SP. AT 3.625 = 14.500
3.75
10-32 SLIDE MTG INSERTS 5 PL BOTH SIDES
PHANTOM LINE INDICATES AREA AROUND EXHAUST FAN TO BE FREE OF OBSTRUCTIONS SO AS NOT TO IMPEDE EFFICIENCY OF COOLING
2.19
4.94
RF SIMPLE OPTIONAL SMA OR TYPE N CONNECTOR
2.63
1.15
1 RF OUTPUT SMA OR TYPE N CONNECTOR
19.00
18.25
.24
3.000
.250 X .375 SLOT, 4 PL

NOTES:

1 RF INPUT & OUTPUT IN FRONT OR REAR DETERMINE BY CUSTOMER REQUIREMENT

NEXT ASSEMBLY	USED ON
MULTI-USE	MULTI-USE

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DECIMALS 1PL ± .1 2PL ± .01

3PL ± .005 FRAC ± 1/64

ANGLE ± 1° SURFACE FINISH ✓

MATERIAL

SPEC NO

FINISH

CONTRACT NUMBER

DR		11-16-80
CHK	J. Day	2-2-81
APPD		11-18-80
APPD		

DESIGN ACTIVITY APPROVAL

CUSTOMER APPROVAL

QTY | IDENTIFYING NUMBER | DESCRIPTION | CODE IDENT | ITEM

LIST OF MATERIAL

varian

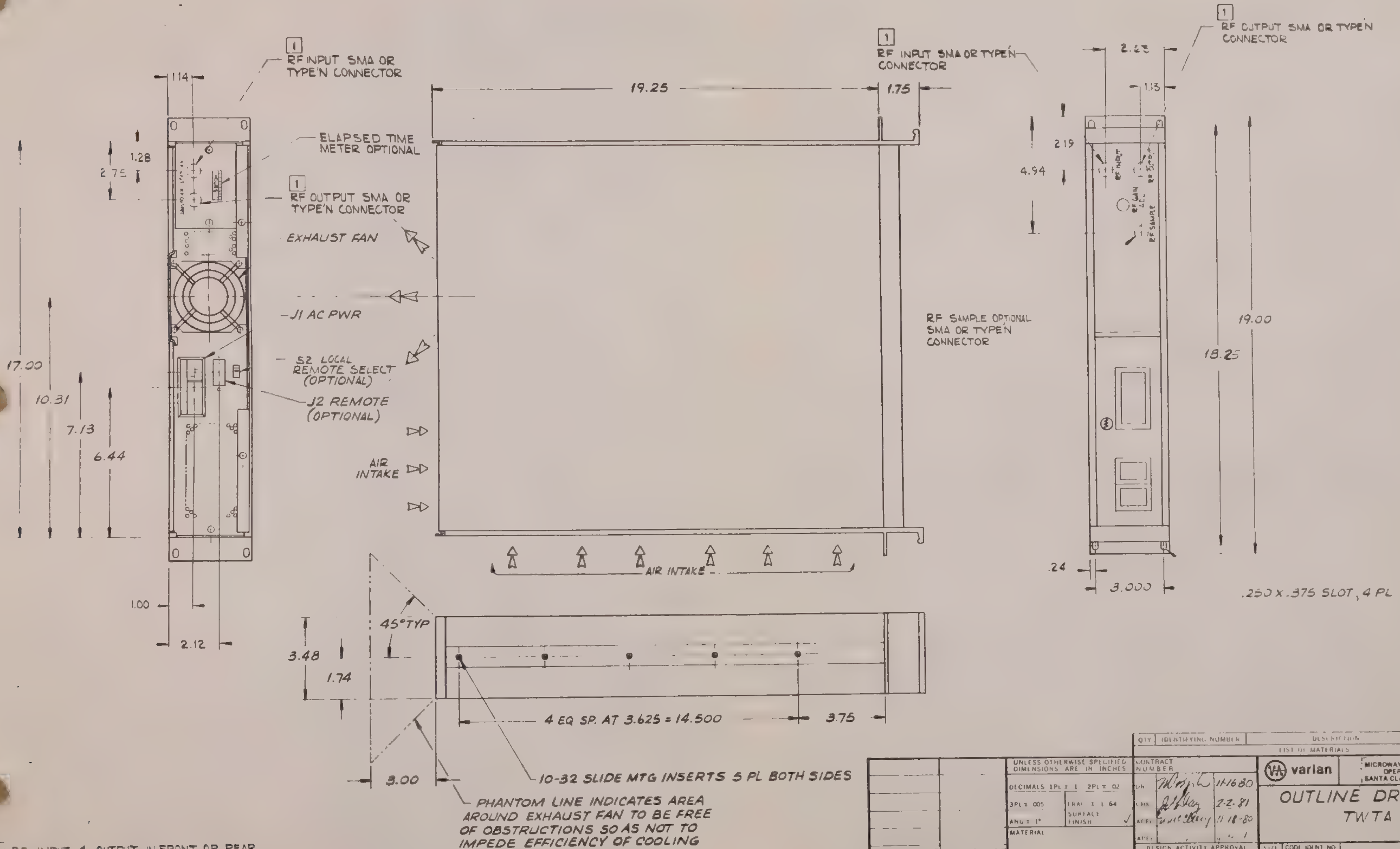
MICROWAVE EQUIPMENT OPERATIONS SANTA CLARA CALIFORNIA

OUTLINE DRAWING
TWTA

SIZE	CODE IDENT NO		
D	59782	135223	A

SCALE 1/2 SHEET 1 OF 1

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED
	A	ADDED RF INPUT & OUTPUT INFO		5/18/81	


1
RF INPUT SMA OR TYPE N CONNECTOR
1.14
1.28
2.75
ELAPSED TIME METER OPTIONAL
1
RF OUTPUT SMA OR TYPE N CONNECTOR
EXHAUST FAN
-J1 AC PWR
S2 LOCAL REMOTE SELECT (OPTIONAL)
J2 REMOTE (OPTIONAL)
17.00
10.31
7.13
6.44
AIR INTAKE
1.00
2.12
19.25
1.75
1
RF INPUT SMA OR TYPE N CONNECTOR
AIR INTAKE
RF SAMPLE OPTIONAL SMA OR TYPE N CONNECTOR
45° TYP
3.48
1.74
4 EQ SP. AT 3.625 = 14.500
3.75
3.00
10-32 SLIDE MTG INSERTS 5 PL BOTH SIDES
PHANTOM LINE INDICATES AREA AROUND EXHAUST FAN TO BE FREE OF OBSTRUCTIONS SO AS NOT TO IMPEDE EFFICIENCY OF COOLING
1
RF OUTPUT SMA OR TYPE N CONNECTOR
2.62
1.13
2.19
4.94
RF INPUT
RF OUTPUT
RF SAMPLE
19.00
18.25
.24
3.000
.250 X .375 SLOT, 4 PL

1 RF INPUT & OUTPUT IN FRONT OR REAR DETERMINE BY CUSTOMER REQUIREMENT

NOTES:

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
LIST OF MATERIALS				

MULTI-USE	MULTI-USE
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER

DR	M	11-16-80
CHK		2-2-81
APPD		11-18-80
APPD		

DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

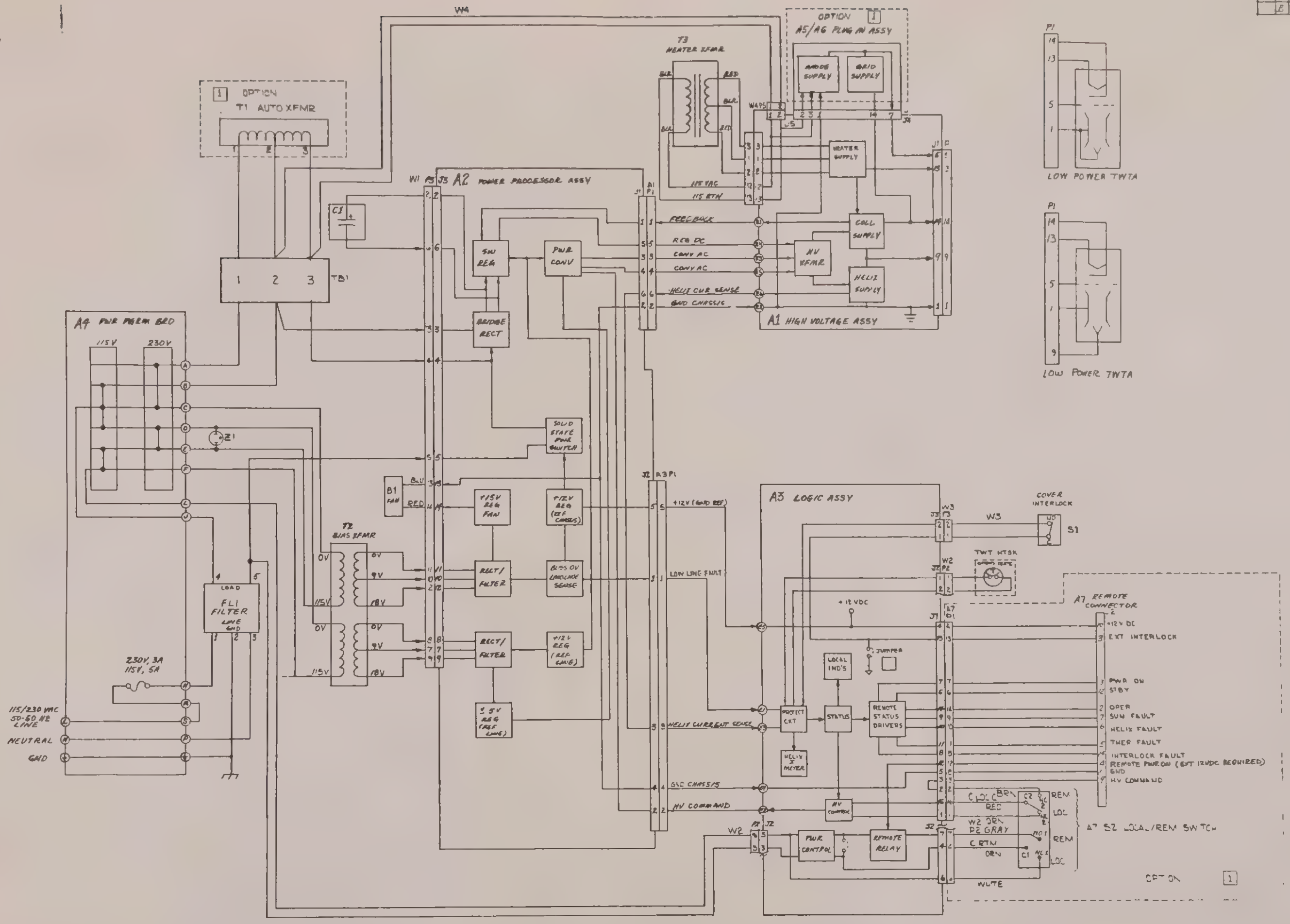
varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA, CALIFORNIA

OUTLINE DRAWING
TWTA

SIZE	CODE IDENT NO		
D	59782	135223	A

SCALE 1/2 SHEET 1 OF 1
SUPERSEDES

ZONE	LTR	DESCRIPTION			APPD
	A	[illegible]			
	B	[illegible]			


W4
1 OPTION
T1 AUTO XFMR
1
2
3
TB1
C1
W1 P3 J3 A2 POWER PROCESSOR ASSY
SW REG
PWR CONV
BRIDGE RECT
SOLID STATE PWR SWITCH
B1 FAN
BLU
RED
+15V REG FAN
+12V REG (REF CHASSIS)
RECT/ FILTER
BIAS OV LOWLINE SENSE
+12V REG (REF LINE)
± 5V REG (REF LINE)
T2 BIAS XFMR
0V
9V
18V
115V
A4 PWR PGRM BRD
115V
230V
Z1
LOAD
FLI FILTER
LINE GND
230V, 3A
115V, 5A
115/230 VAC 50-60 HZ LINE
NEUTRAL
GND
T3 HEATER XFMR
BLK
RED
115 VAC
115 RTN
OPTION 1
A5/A6 PLUG IN ASSY
ANODE SUPPLY
GRID SUPPLY
W4 P5
J5
J4
A1 P1
FEEDBACK
REG DC
CONV AC
CONV AC
HELIX CUR SENSE
GND CHASSIS
HEATER SUPPLY
COLL SUPPLY
HV XFMR
HELIX SUPPLY
J1 P
A1 HIGH VOLTAGE ASSY
P1
LOW POWER TWTA
P1
LOW POWER TWTA
J2 A3 P1
+12V (GND REF)
LOW LINE FAULT
HELIX CURRENT SENSE
GND CHASSIS
HV COMMAND
A3 LOGIC ASSY
J3 W3 P3
W3
COVER INTERLOCK
NO
S1
TWT HTSK
J2 W2 P2
+12 VDC
JUMPER
LOCAL IND'S
PROTECT CKT
STATUS
REMOTE STATUS DRIVERS
HELIX I METER
HV CONTROL
PWR CONTROL
REMOTE RELAY
W2 P2 J2
J1 A7 P1
S2
A7 REMOTE CONNECTOR
+12V DC
EXT INTERLOCK
PWR ON
STBY
OPER
SUM FAULT
HELIX FAULT
THER FAULT
INTERLOCK FAULT
REMOTE PWR ON (EXT 12VDC REQUIRED)
GND
HV COMMAND
C LOC BRN
RED
W2 ORN
P2 GRAY
C RTN
ORN
WHTE
C2
C1
NC
NO
REM
LOC
A7 S2 LOCAL/REM SWITCH
OPTION 1

NOTES:

1 REFER TO TWTA FINAL ASSY DWG TO DETERMINE WHETHER OPTION IS INCLUDED.

QTY	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
LIST OF MATERIALS				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS .XX ± .1 .XXX ± .01
.XXX ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH N/A

NEXT ASSEMBLY | USED ON
APPLICATION

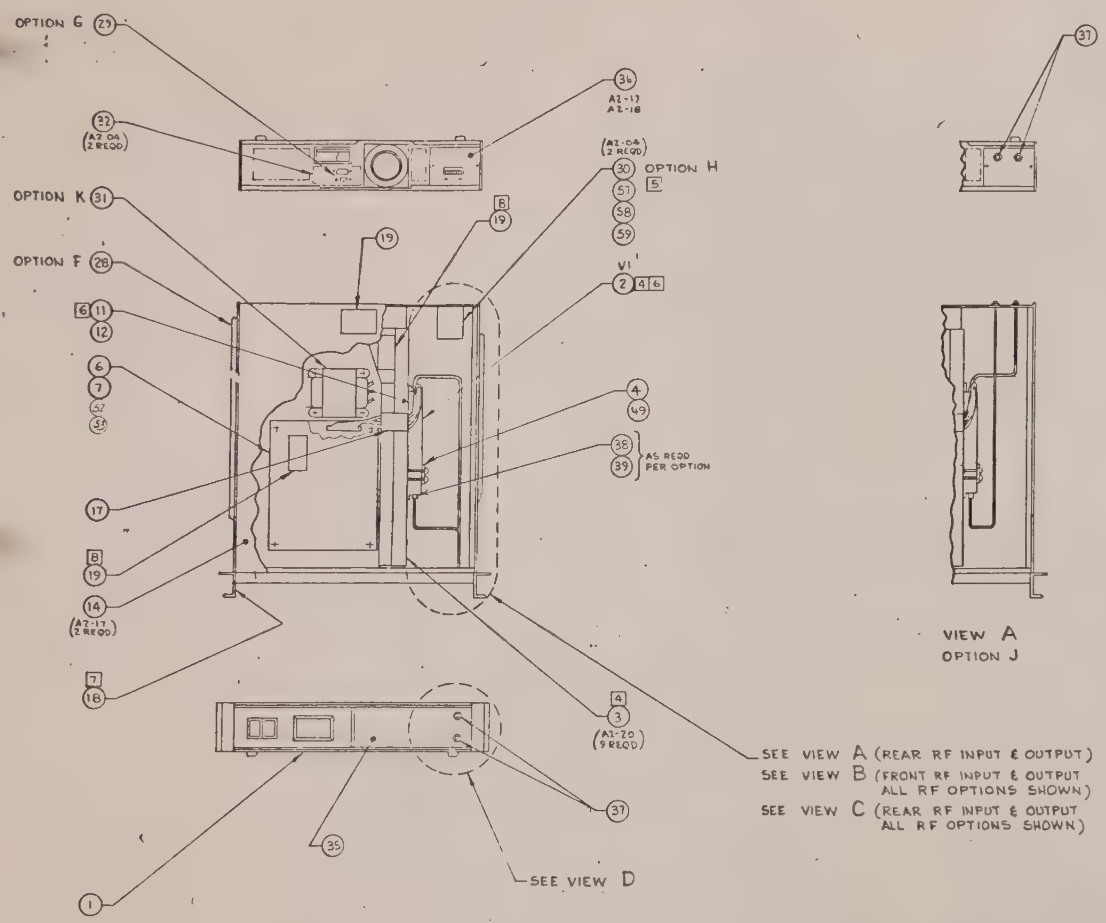
CONTRACT NUMBER
DR [illegible] 10-31-80
CHK [illegible]
APPD [illegible] 2-9-81
APPD [illegible]
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA

SCHEMATIC POWER SUPPLY

SIZE E | CODE IDENT NO 59782 | 135228 | B
SCALE N/A | SHEET 1 OF 1
SUPERSEDES

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVE
	A	DELETE CONNECTOR ASSY	—	10/14/81	D CHC



SEE VIEW A (REAR RF INPUT & OUTPUT)
SEE VIEW B (FRONT RF INPUT & OUTPUT ALL RF OPTIONS SHOWN)
SEE VIEW C (REAR RF INPUT & OUTPUT ALL RF OPTIONS SHOWN)

LIST OF MATERIALS CONTINUED ON SHEET 2

2 OPTIONS	QTY WITH OPTION	QTY ALL MODELS	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
		REF	D135223-00	OUTLINE		45
		REF	C01001000	TWTA MODEL NUMBER BREAKDOWN		44
		1	B01000420	SEE TABLE 3 SHIPKIT		43
						42
						41
DEE	1		58-180102	ADAPTER, SMA, PLUG TO PLUG		40
	AR	AR	82-299901	CABLE, SEMI-RIGID, .141		39
	AR	2	58-180100	CONNECTOR, PLUG, SMA		38
		2	58-180105	CONNECTOR, BULKHEAD JACK, SMA		37
H,J		1	SEE TABLE 2	PLATE, REAR		36
B,E,J		1	SEE TABLE 1	PANEL, FRONT, RIGHT		35
						34
						33
		1 9	B01000133-00	COVER PLATE		32
K	1		E01000443-00	115/230 OPTION KIT		31
H	1 5		76-789814 76-789815	INDICATOR, ELAPSED TIME, 115V, 50HZ INDICATOR, ELAPSED TIME, 115V, 60HZ		30
G	1		C01000444-00	REMOTE CONTROL OPTION KIT		29
F	1PR		21-301120	SLIDE, ZERO # C-300-S-20		28
E	1		83-330016	DIRECTIONAL COUPLER		27
	1		58-180105	CONNECTOR, BULKHEAD JACK, SMA		26
D	1		A057648-07	ISOLATOR, OUTPUT		25
C	1		83-460014	HARMONIC FILTER		24
B	1		23-508002	KNOB		23
	1		83-439947	ATTENUATOR, VARIABLE		22
A	1		83-469858	ISOLATOR, INPUT		21
						20
		3	B112379-00	LABEL, DANGER		19
		1	01000500	LABEL		18
			01000503	CHANNEL, WRNG		17
		AR	88-258900	THERMAL COMPOUND		16
						15
		1	C135207-00	COVER, MODIFIED		14
						13
		4	51-40[illegible]0	CONNECTOR SOCKET		12
		1	51-411032	CONNECTOR, 1450C		11
						10
						9
						8
		1	C135187-04	STAND OFF		7
		1	C135186-00	COVER, HIGH VOLTAGE		6
						5
		1	01000593	PLATE, TWT CLAMPING		4
		1	01000480-01	HEATSINK MOD		3
		1	VTM-6096R1	TWT		2
		1	E135216-00	ASSY, POWER SUPPLY		1

LIST OF MATERIALS

STANDARD OPTIONS	
OPTION	DESCRIPTION
A	INPUT ISOLATOR
B	INPUT ATTENUATOR
C	HARMONIC FILTER
D	OUTPUT ISOLATOR
E	OUTPUT SAMPLE PORT
F	CHASSIS SLIDES
G	REMOTE INTERFACE
H	ELAPSED TIME METER
J	REAR RF CONNECTOR
K	115/230 VAC PRIME PWR

11

NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH ✓
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER

DR	ZYoung	21SEPT.81
CHK	JL	9-30-81
APPD	A. Cho	9/30/81
APPD	June Ornido	11/11/81

DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA

TWTA
FINAL ASSEMBLY
VZM-6990K1 SERIES 1

SIZE D CODE IDENT NO. 59782 01000592 A
SCALE — SHEET 1 OF 2
SUPERSEDES

REVISIONS					
ZONE	LTR	DESCRIPTION	EO	DATE	APPROVED

NOTES:

1. [1] IF THE LAST FOUR DIGITS OF THE MODEL NO. ARE NUMERICALLY CODED (ie 6990KI1234) THE MODEL IS NOT COVERED IN THIS DRAWING. SEE DRAWING 01001234.
2. [2] INSTALL OPTIONS ACCORDING TO TWTA MODEL NO. EXAMPLE, IF TWTA MODEL NO. IS 6990KI ACEG OPTIONS ARE A, C, E AND G
   SEE RF SCHEMATIC DIAGRAM
   FOR ASSEMBLIES OF OPTIONS A B C D & E
3. 3 STANDARD HARDWARE PER C110625, EXAMPLE (A2-18 / 2 REQD)
4. [4] APPLY A UNIFORM THIN COATING OF THERMAL COMPOUND ITEM 16 BETWEEN MOUNTING SURFACES OF ITEMS 2 & 3.
5. [5] SELECT EITHER 50HZ OR 60HZ ELAPSED TIME INDICATOR ITEM 30 AS SPECIFIED ON CUSTOMER ORDER. CONNECT ITEM 30 TO TB1-3 AND TB1-2 USING ITEMS 57, 58 AND 59.
6. [6] CONNECT TWT ITEM 2 TO CONNECTOR ITEM 11 WITH CONNECTOR SOCKETS ITEM 12 PER A 01000643.
7. [7] NAME PLATE DATA
   TWTA: (USE MODEL NO. SPECIFIED ON CUSTOMER ORDER)
   FREQ: 8.0-18.0 GHZ
   GAIN: 35 dB
8. [8] REMOVE PORTION OF LABEL THAT READS "EXPOSED WHEN COVER REMOVED".
9. [9] IF OPTION G IS REQUIRED DELETE ITEM 32.
10. [10] INSTALL REQUIRED OPTIONS IN THE APPROXIMATE PLACE AS SHOWN AND CONNECT RF COMPONENTS IN ORDER SHOWN ON RF SCHEMATIC DIAGRAM.
11. [11] SEE SHIP KIT FOR CUSTOMER INTERFACE OF PRIME POWER.

FRONT PANEL TABLE 1

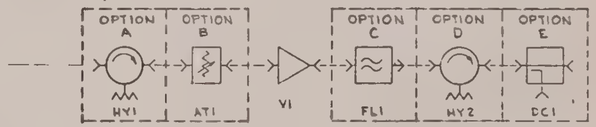
PART NO	B OPTION	E OPTION	J OPTION
D01000417-06			
D01000417-08		X	
D01000417-07	X		
D01000417-10	X	X	
D01000417-00			X
D01000417-01		X	X
D01000417-03	X		X
D01000417-04	X	X	X

REAR PLATE TABLE 2

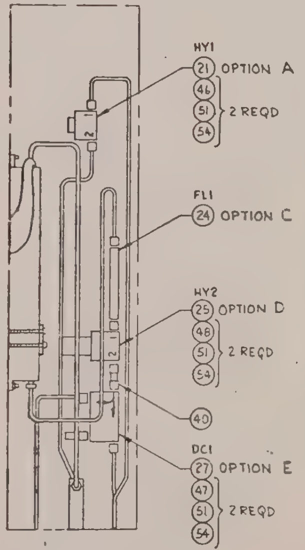
	H OPTION	J OPTION
C01000418-00		
C01000418-01	X	
C01000418-02		X
C01000418-04	X	X

TABLE 3

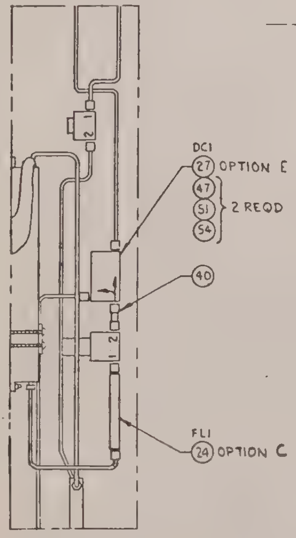
PART NO.	"G" OPTION	"K" OPTION
B01000420-00		
B01000420-01		X
B01000420-02	X	
B01000420-03	X	X



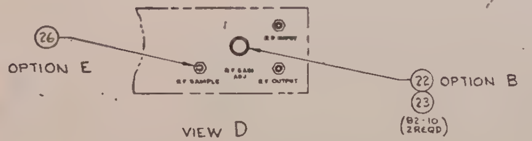
RF SCHEMATIC DIAGRAM
(ADD OPTIONS AS SPECIFIED IN ORDER SHOWN ABOVE)



VIEW B [10]
SCALE: NONE
FRONT RF INPUT & OUTPUT
ALL RF OPTIONS SHOWN



VIEW C [10]
SCALE: NONE
REAR RF INPUT & OUTPUT
ALL RF OPTIONS SHOWN



VIEW D
SCALE: NONE

OPTIONS [2]	QTY WITH OPTION	QTY ALL MODELS	IDENTIFYING NUMBER	DESCRIPTION	CODE IDENT	ITEM
						67
						66
						65
						64
						63
						62
						61
						60
H	AR		81-288700	WIRE, TYPE EE, 24 AWG, BLACK		59
	AR		88-488001	SHRINK TUBING 1/8 DIA		58
	2		15-999902	TERMINAL, QUICK DISCONNECT		57
						56
						55
A, E, D	AR		14-202002	WASHER, LOCK, #2		54
		–	12-222006-07	PAN HD SCREW, #6		53
		–	14-[illegible]	INTERNAL LOCK WASHER		52
A, E, D	AR		14-122002	WASHER, FLAT, #2		51
						50
	4		12-222060-32	SCREW, PAN HD [illegible]-32 × 2 1/4 LG		49
D	2		12-162002-05	SCREW, PAN HD, 2-56 × 5/16 LG		48
E	2		12-162002-22	SCREW, PAN HD, 2-56 × 1 1/4 LG		47
A	2		12-162002-05	SCREW, PAN HD, 2-56 × 5/16 LG		46

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS 1PL ± .1 2PL ± .02
3PL ± .005 FRAC ± 1/64
ANG ± 1° SURFACE FINISH
MATERIAL
SPEC NO
FINISH

CONTRACT NUMBER
DR
CHK
APPD
APPD
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL

varian
MICROWAVE EQUIPMENT OPERATIONS
SANTA CLARA CALIFORNIA

TWTA
FINAL ASSEMBLY
VZM-6990KI SERIES [1]

SIZE D
CODE IDENT NO 59782
01000592 A
SCALE —
SHEET 2 OF 2
SUPERSEDES

HIGH VOLTAGE EQUIPMENT PERSONNEL OPERATING GUIDELINES

1.0 INTRODUCTION

This guideline document presents operating practices for operators and technicians who work with high voltage equipment. In the context of this discussion any voltage that is lethal is viewed as "high voltage". Therefore, even prime power (115 to 440 VAC) is dangerous because prime power potentials have been known to cause death or injury. (See Section 2.0)

THERE ARE NO OLD CARELESS HIGH VOLTAGE TECHNICIANS

Electrical circuits operate quickly and do not allow a careless individual a second chance. When dealing with high voltage, the results are very consistent and predictable and hazards associated with high voltage are always present. THE FACT THAT THE CONTROL SWITCH SAYS OFF DOES NOT MEAN YOU ARE SAFE. Many high voltage circuits are like loaded guns. IN GENERAL, YOU CANNOT SEE A HIGH VOLTAGE HAZARD. You can learn to recognize situations that present a threat and how to avoid them.

The guidelines presented in this guide are not academic. They are based on the experience of engineers and technicians who have years of experience with high voltage circuits.

2.0 WHEN IS VOLTAGE "HIGH"?

As stated earlier, any voltage that will kill you should be treated as "high voltage". Voltages associated with prime power generally do not jump the air gap between people and the equipment. Usually exposed circuit elements such as a terminal, bare piece of wire, or some other non-insulated surface must be touched. One of the problems associated with prime power is that some equipment can be "floating" above ground. In this case, if you place one hand on the equipment chassis and the other on on

earth ground you can be jolted, injured or killed. 440 VAC can stimulate an involuntary muscle response that will either literally throw you across a room or seize and hold you across the voltage terminals. 600 or more volts can hold you indefinitely. If the potential is sufficient to drive 200 milliamps through your body you will be held indefinitely. Some people consider the 200 to 600 volt range to be worse than potentials of thousands of volts.

3.0 GENERAL GUIDELINES

In addition to the above, the following practices have proven effective for personnel who deal with high voltage equipment.

a. HANDS OFF. Avoid contact with any potential source of high voltage. Keep your hands out of the equipment when it is operating.

b. AVOID ACCIDENTAL CONTACT. Make sure that some other part of your body does not come in contact with the high voltage circuits. It is easy to forget the hazards when you are concentrating on a frustrating or interesting task. Pens and badges in shirt pockets could cause contact.

c. NEVER WORK ON HIGH VOLTAGE CIRCUITS WHEN YOU ARE ALONE. If anything should happen to you, your only chance may be prompt action by some other person. Be sure someone else is present and knows what to do in an emergency. (eg. how to shut the equipment off, first aid, who to call, etc.)

d. USE ONE HAND WHEN WORKING WITH HIGH VOLTAGE CIRCUITS. Many people recommend that you put one hand in your pocket when you use a probe or other piece of equipment inside a high voltage section.

e. DO NOT FLOAT MEASURING EQUIPMENT ABOVE GROUND. Make all measurement with respect to ground. The odds are that if you float the instrument, you may forget and reach inside the equipment. Although it is harder to get the right test setup, it is well worth the effort.

f. DO NOT ASSUME THAT THE LEVEL OF RISK IS A FUNCTION OF SIZE. Some large high power high voltage equipment looks docile. One reason the equipment is so big is to get the proper separation between high voltage points. On the other hand, just because the equipment is small is no assurance of safety. Dense packaging results in more difficult access and increases the chance that you will accidentally hit the wrong point.

g. ALWAYS DISCHARGE HIGH VOLTAGE CAPACITORS. High voltage capacitors store a lot of energy for long periods of time. High voltage capacitors also exhibit a "memory" in that they can recover after discharge and reach lethal levels. In addition to the "memory" problem, there have been instances where the built-in safety features have failed or been miswired. Each and every time you go to work on a piece of high voltage equipment use a grounding rod with a long handle to discharge every high voltage capacitor.

h. DO NOT DEPEND ON THE AUTOMATIC FEATURES OF THE EQUIPMENT TO SAVE YOU. You never know when someone has left a circuit disabled, or if there has been a wiring error, or if a component has failed.

i. TAKE PERSONAL RESPONSIBILITY TO ASSURE THAT NO ONE CAN TURN ON THE HIGH VOLTAGE CIRCUITS WHEN YOU ARE WORKING ON THE EQUIPMENT. Precautions would include taping down (or installing keepers) on controls/circuit breakers and/or disconnecting the power source to the high voltage circuits, activating interlocks that prevent high voltage turn on etc. Know where the disconnects are and use them. Do not rely on anyone not to turn on the high voltage.

j. SET UP YOUR TEST EQUIPMENT WITH THE POWER OFF. Conduct the power-on operations when you have your hands out of the equipment.

k. DO NOT USE SHORT PROBES FOR HIGH VOLTAGE MEASUREMENTS. A short probe does not allow any margin for error. If your hand slips you could accidentally come into contact with a danger point. A long probe avoids the whole problem.

l. READ THE INSTRUCTION MANUAL. The best insurance is foreknowledge of hazards.

m. CREATE A FAVORABLE ENVIRONMENT FOR SAFE OPERATIONS. This means that if people are crowding about you, stop the operation if it involves high voltage. Pressure can lead to carelessness. In the same way, fatigue is also an enemy. STAY ALERT AT ALL TIMES WHEN WORKING WITH HIGH VOLTAGE.

n. DO NOT BECOME OVER CONFIDENT. Maintain a healthy respect for high voltage.

o. A GOOD OPERATING PRACTICE IS TO CHECK THE POTENTIAL BETWEEN THE EQUIPMENT CHASSIS AND EARTH GROUND BEFORE YOU COMPLETE THE CIRCUIT WITH YOUR BODY. As voltage levels increase, the protection you get from insulation and air gap diminishes. For example, in a piece of equipment that involves beam voltages of about 16 KV, the beam transformers look very safe with massive insulation on the outside of the coils. Physical contact with the beam coil when the system is operating can be fatal. Although the equipment is placarded to warn people of the presence of high voltage, it is virtually impossible to placard every point of danger in a system.

p. IF YOU DO NOT KNOW HOW THE EQUIPMENT WORKS AND WHAT THE HAZARDS ASSOCIATED WITH THE EQUIPMENT ARE IN SPECIFIC TERMS, DO NOT HANDLE THE EQUIPMENT. The greatest protection you can have when dealing with high voltage equipment is specific, detailed knowledge on that particular piece of equipment.

q. AVOID "HAYWIRE" TEST SETUPS. It is easy to get in trouble if the setup you are using has a jumble of wires.

r. MAKE SURE YOUR CONNECTIONS ARE SECURE. Do not allow leads to slip off and move about in an uncontrolled fashion. Even if it is not one of the high voltage leads, a free lead could (and generally does) move exactly to where you do not want it. The only safe connection is a mechanically secure one.

s. WATCH OUT FOR UNTERMINATED HIGH VOLTAGE LEADS. Some connectors depend on circuit loading to avoid arcing between closely spaced terminals. Unloaded high voltage lines or plugs can lead to arcing situations.

t. SHUT OFF THE HIGH VOLTAGE WHEN YOU ARE MAKING LOW VOLTAGE MEASUREMENTS. It does not make any sense to increase danger needlessly. While there may be times when you cannot shut off the high voltage during a low voltage measurement this is generally not the case.

u. REMOVE THE TEST EQUIPMENT WHEN YOU HAVE FINISHED A MEASUREMMENT PROGRAM. There has been many instruments destroyed or damaged because a test program was conducted in a haphazard manner rather than in an orderly progression from start to finish. Experience has shown many instances when a little order would have prevented a tragedy or avoided an expensive mistake.

v. BE EXTREMELY WARY WHEN MAKING FILAMENT VOLTAGE MEASUREMENTS. The cathode of tubes is elevated above (or below) ground and the filament voltages usually cannot be made with reference to ground. Do everything you can to assure that the high voltage cannot be turned on when you are making your measurements. This includes disconnecting the high voltage drive source, shorting out appropriate leads, taping down switches and anything else you can think of to protect yourself.

w. WHEN TROUBLE SHOOTING A UNIT ASSUME THAT THE SWITCHES AND COMPONENTS ARE DEFECTIVE. You may shut off the high voltage switch in some systems, but if the switch is defective you would still have the high voltage on. Returned units are potential booby traps.

x. MAKE SURE THAT YOUR WORK STATION IS STABLE. Flimsy work surfaces or supports for the equipment or the test instruments represent a real threat. Do not use a setup that you know is unstable and/or dangerous.

y. USE THE 30 SECOND RULE. Wait 30 seconds after you have shut off the equipment before you work on a unit. Part of the reason for the 30 second rule is that some of the dielectrics (insulators) used for high voltage circuits can store a charge. While the amount of charge stored is a function of the size of the object the 30 second rule provides an additional margin of safety.

z. MAINTAIN A HEALTHY RESPECT FOR ANY KIND OF LIVE CIRCUITS. COMPLACENCY CAN HURT YOU OR KILL YOU. Your continued wariness is your best insurance against injury or death.

MICROWAVE RADIATION PERSONNEL OPERATING GUIDELINES

1.0 INTRODUCTION

This guideline document presents operating practices appropriate for operators and technicians who work with equipment involving microwave radiation. Keep in mind that levels of microwave radiation that do not induce immediate physical discomfort in most individuals can be sufficiently high to induce longer term effects. Varian MCSD equipment usually is related to amplification of an RF signal from an external source. Even if a source is not connected to the amplifier you are working with, there are situations where the amplifier can go into a self induced mode and generate high levels of RF energy. This condition can exist if the unit is operataed with the high voltage on and without proper termination on the input and output of the amplifier.

> PROTECT YOURSELF AND THOSE AROUND YOU FROM UNWANTED RF EXPOSURE. ALWAYS TERMINATE THE AMPLIFIER INPUT AND OUTPUT WITH A RF DUMMY LOAD (or a short) BEFORE YOU TURN THE HIGH VOLTAGE ON. This will reduce the chances of oscillation due to internal amplifier noise.

2.0 DISCUSSION

Limit exposure to microwave radiation to prevent unwanted biological effects. There are other effects that can lead to problems if you are careless in operating or servicing microwave equiment. The permissable levels are quite low in comparison to the power levels of the amplifiers built by Varian. (eg less than 10 milliwatts vs 20 to 10,000 watts delivered by different units). Local radiation levels can be detected with the proper equipment. The permissable levels are currently being studied by a number of organizations. In the past the US Safety codes estab-

lished a dozage rate number of 10 mw/cm. sq. Currently there is consideration being given to reducing the permissable level to 1 mw/cm. sq. in the United States as has been the case for several European countries.

3.0 GENERAL GUIDELINES

The purpose of these guidelines is to provide practical approaches to control unwanted microwave energy associated with the operation and servicing of Varian equipment. The following approaches are effective in both laboratory or field environments.

a. ALWAYS TERMINATE THE OUTPUT WAVEGUIDE OR CONNECTOR WITH A DUMMY RF LOAD (CAPABLE OF DISSIPATING FULL CW RF POWER) OR AN APPROPRIATE SHORT. SIMILARLY, TERMINATE THE INPUT TO AVOID THE POSSIBILITY OF THE AMPLIFIER BEING DRIVEN BY STAY LEAKAGE SIGNALS. Incorporate the terminations prior to applying prime power to the amplifier. This procedure prevents self oscillation and irradiation of the local environment.

b. DO NOT LOOK INTO THE OUTPUT PORT OF A POWERED RF AMPLIFIER. Treat the powered amplifier as though it is a loaded gun. Your eyes are particularly vulnerable parts of your body.

c. SHUT OFF THE UNIT IF YOU ARE TRYING TO LOCATE AN RF LEAK. As noted earlier, the levels of concern are very low. Examine the physical unit with the high voltage off. If you have to survey the RF runs with the power on to find the leaky joint or component, start by testing the system with a radiation meter. If the microwave radiation exceeds 0.5 mw/cm. sq. shut off the high voltage and consult your supervisor. Work quickly (not at a panic pace) to minimize the dose level. The dose you get is directly proportional to the power level and the time you are exposed.

Exposure to microwave radiation can induce both thermal and non-thermal biological effects, especially with the eyes. If you damage the lens of your eye by exposure to microwave radiation, cataracts can result. Consider that small microwave ovens are very effecting in cooking foods. If you follow these guidelines you can minimize exposure of yourself and other people in the area to excessive levels of microwave radiation associated with the operations that you control.

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WARRANTY

LIMITED WARRANTY FOR PRODUCTS OF MICROWAVE COMPONENTS AND SUBSYSTEMS DIVISION

VARIAN ASSOCIATES, INC.

1. WARRANTY

a. Equipment, components, and subsystems (i.e. "Products"), exclusive of microwave tubes, manufactured and sold by Varian Microwave Components and Subsystems Division (MCSD) are warranted to be free of defects in material and workmanship for a period of one (1) year except as otherwise specified on Varian's quotation or agreed to in writing by Varian. Varian's obligation under all MCSD warranties is limited in accordance with the periods of time and all other conditions stated in all provisions of this warranty.

b. This warranty applies only to defects in material and workmanship in Products manufactured by Varian, including non-Varian parts, except microwave tubes. Varian makes no warranty whatsoever concerning Products or Accessories not of its manufacture.

c. Microwave tubes, which are supplied as an integral part of MCSD Products, are warranted only in accordance with the Tube Manufacturer's applicable warranty.

d. Power Supplies and passive components which include electromagnets, solenoids, filters, waterloads, circulators, couplers, waveguide windows, diplexers, and other passive devices are warranted for one (1) year of unlimited hours of operation following the date of shipment thereof, unless otherwise specified.

e. Repair, or at Varian's option, replacement of the Varian Product or defective parts therein shall be the sole and exclusive remedy for all valid warranty claims; provided that under certain circumstances Varian may, as an alternative, elect to refund an equitable portion of the purchase price of the Product.

2. WARRANTY PERIOD

The applicable warranty period shall commence on the date of shipment from Varian's Microwave Components and Subsystems Division (MCSD) to the original purchaser and extend for the stated period following the date of shipment. The warranty period for microwave tubes shall commence on the date of shipment from MCSD and extend for the specified number of hours of operation in accordance with the terms of the applicable express written warranty of the Tube Manufacturer. Upon beginning of the applicable Varian warranty period, all customer's remedies shall be governed by the terms stated or referenced in this warranty. In-warranty repaired or replacement Products or parts are warranted only for the remaining unexpired portion of the original warranty period applicable to the repaired or replaced Products or parts. Repair or replacement of Products or parts under warranty does not extend the original warranty period.

3. WARRANTY COVERAGE LIMITATIONS

a. The following are expressly **not covered** under warranty:

1) Any loss, damage, and/or malfunction relating in any way to shipping, storage, accident,abuse, alteration, misuse, neglect, failure to use Products under normal operating conditions or within respective Varian specified ratings, failure to use Products according to any operating instructions provided by Varian, lack of routine care and maintenance as indicated in any operating or maintenance instructions, or failure to use or take any proper precautions under the circumstances.

2) Products, items, parts, accessories, subassemblies, or components which are expendable in normal use or are of limited life, such as but not limited to bulbs, fuses, lamps, glassware, etc.

3) Microwave tubes, except as provided in the Tube Manufacturer's applicable express written warranty.

b. Varian reserves the right to revise theforegoing list of what is not covered under this warranty.

4. WARRANTY REPLACEMENT AND ADJUSTMENT

The Warranty Replacement and Adjustment provisions stated in the standard Terms and Conditions of Sale, Electron Device Group, Varian Associates, Inc., are incorporated herein by reference. In addition thereto, the following provisions shall apply to replacement of parts under warranty in MCSD Products.

a. At Varian's sole option, it may furnish warranty replacement parts to the Customer before the defective part is returned to and received by Varian. If Varian furnishes such parts in advance, the Customer understands and agrees that it will return the replaced defective parts to Varian within sixty (60) days after Varian's advance shipment. In the event defective parts are not returned and received by Varian within this sixty (60) day period, the advance replacement parts shall be deemed not furnished under warranty and Customer agrees to pay Varian's invoices for all such advance shipment replacement parts at their then current selling prices.

b. Varian will not make warranty adjustments for failures of Products or parts which occur after the specified warranted hours of operation or after the specified maximum adjustment period. Unless otherwise agreed, failure shall be deemed to have occurred no more than seven (7) working days before the first date on which a notice of failure is received by Varian. Under no circumstances shall any warranty exceed the period stated above unless expressly agreed to in writing by Varian. In the event Customers and/or users of any Varian MCSD Products subject to this warranty fail to keep accurate records of the number of hours of operation or time period of use, Varian, at its sole discretion, may reject any such claims or determine probable usage for the equipment, component, or subsystem involved.

5. LIABILITY LIMITATIONS

a. THIS WARRANTY IS EXPRESSLY IN LIEU OF AND EXCLUDES ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR PARTICULAR PURPOSE, USE, OR APPLICATION, AND ALL OTHER OBLIGATIONS OR

Pub. No. 7904 4/79 Printed in U.S.A

LIABILITIES ON THE PART OF VARIAN, UNLESS SUCH OTHER WARRANTIES, OBLIGATIONS OR LIABILITIES ARE EXPRESSLY AGREED TO IN WRITING BY VARIAN.

b. All obligations of Varian under this warranty shall cease in the event its Products or parts thereof have been subjected to accident, abuse, alteration, misuse or neglect, or which have not been operated and maintained in accordance with proper operating procedures.

c. IN NO EVENT SHALL VARIAN BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, SPECIAL, OR RESULTING LOSS OR DAMAGE OF ANY KIND HOWSOEVER CAUSED. VARIAN'S LIABILITY FOR DAMAGES SHALL NOT EXCEED THE PAYMENT, IF ANY, RECEIVED BY VARIAN FOR THE UNIT OR PRODUCT OR SERVICE FURNISHED OR TO BE FURNISHED, AS THE CASE MAY BE, WHICH IS THE SUBJECT OR CLAIM OR DISPUTE.

d. No action, regardless of form, arising out of, or in any way connected with, the Products, or services, furnished or to be furnished by Varian, may be brought by the Customer more than one (1) year after the cause of action has accrued. All patent liability of Varian shall be determined solely in accordance with the standard Terms and Conditions of sale, Electron Device Group, Varian Associates, Inc.

e. Statements made by any person, including representatives of Varian, which are inconsistent or in conflict with the terms of this warranty, shall not be binding upon Varian unless reduced to writing and approved by an officer of Varian.

RETURN PROCEDURES

6. WARRANTY CLAIM

All claims under warranty must be made promptly after occurrence of circumstances giving rise to the claim and must be received within the applicable warranty period by Varian or its authorized representative. Varian reserves the right to reject any warranty claim not promptly reported. After expiration of the applicable warranty period, Microwave Tubes, Power Supplies and Components are not subject to adjustment.

Unnecessary expense and loss of time often can be avoided by calling the local Varian Field Office before returning a Product to the factory. Returned Products are frequently found to be within performance specifications required of new Products. The Varian representative may be able to determine the trouble and obtain satisfactory performance from the Product. This may save shipping time and expense and minimize equipment down time.

7. WARRANTY CLAIM FORM

Before any Product is returned for repair and/or adjustment, written authorization from Varian for the return and instructions as to how and where the Product should be shipped must be obtained. The Product type and serial numbers and a full description of the circumstances giving rise to the warranty claim should be included. Such information will help establish the cause of failure and expedite adjustment or repair. For this purpose, a **Warranty Claim Form** is shipped with each Product.

8. IMPORTANT

Any Product returned without a completed claim form will be considered to have met all contractual requirements. Both the Product and the completed claim form must be submitted to Varian Associates, Inc. prior to expiration of the applicable warranty period.

9. TRANSPORTATION AND PACKAGING

Any Product returned to Varian for examination must be sent prepaid via the means of transportation indicated as acceptable by Varian. Varian reserves the right to reject any warranty claim on any item that has been altered or has been shipped by nonacceptable means of transportation. Returned Products should be carefully packaged in the original container, and unless otherwise indicated, shipped to:

VARIAN ASSOCIATES, INC.
Microwave Components and
Subsystems Division
3200 Patrick Henry Drive
Santa Clara, California 95054

Attn: Customer Support

10. AUTHORIZATION FOR EVALUATION

When any Product is returned for examination and inspection, or for any other reason, Customer and its shipping agency shall be responsible for all damage resulting from improper packing or handling, and for loss in transit, notwithstanding any defect or nonconformity in the Product. By returning a Product, the owner grants Varian Associates, Inc. permission to open and disassemble the Product as required for evaluation. In all cases Varian has sole responsibility for determining the cause and nature of failure, and Varian's determination with regard thereto shall be final.

If it is found that Varian's Product has been returned without cause and is still serviceable, the Customer will be notified and the Product returned at its expense; in addition, a charge for testing and examination may, in Varian's sole discretion, be made on Product so returned.

Varian Microwave Components and Subsystems Division Products are manufactured by Varian Associates, Inc./Headquarters: 611 Hansen Way, Palo Alto, California 94303. Address all inquiries regarding MCSD warranties to the Microwave Components and Subsystems Division, 3200 Patrick Henry Drive, Santa Clara, California 95050

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WARRANTY

MICROWAVE TUBES, POWER SUPPLIES AND COMPONENTS
PALO ALTO MICROWAVE TUBE DIVISION OF VARIAN ASSOCIATES, INC.

WARRANTY

Microwave Tubes and Devices (Products) sold by Varian are warranted against defects in workmanship and material when used under normal operating conditions within the respective Varian specified ratings and in accordance with Varian operating instructions. The applicable Microwave Device warranty period shall commence on the date of shipment from Varian and extend for a specified number of hours of operation of the filament or heater, or for a specified number of months following the date of shipment thereof, whichever first occurs. The applicable number of hours of operation of the filament or heater included in the warranty for a Microwave Tube Device depends upon the type of device. The most common periods of warranty are listed below:

CODES

Group	Warranty Code	Warranted Filament or Heater Operation (Hours)	Maximum Adjustment Period (Months)
A	W-U	Unlimited	12
	W-1000	1000	12
	W-2000	2000	12
	W-5000	5000	12
	W-7500	7500	24
	W-10,000	10,000	36
B	C-1	N/A	12
C	WC-5000	5000	12
	WC-7500	7500	12
		Non-Pro Rata Period (Months)	Pro Rata Period (Months)
D	W-12	4	12
	W-18	6	18
	W-24	6	24
	W-36	6	36

Repair, or at Varian's option, replacement of the Product or defective parts therein shall be the sole and exclusive remedy under valid warranty claims; provided that Varian may, as an alternative, elect to refund an equitable portion of the purchase price of the Product in accordance with the following adjustment criteria.

If a Microwave Tube in Group A fails from causes covered by this warranty within the warranted hours of operation and maximum adjustment period, a pro rata adjustment, based on the selling price, will be made as follows:

$$\text{Adjustment} = (\text{Applicable Selling Price}) \times \left[\frac{(\text{Warranted Hours} - \text{Hours of Operation at Failure})}{\text{Warranted Hours}}\right]$$

Passive Components in Group B, including electromagnets, solenoids, filters, waterloads, circulators, couplers, waveguide windows, diplexers, and other passive devices are warranted for unlimited hours of operation during the one year period following date of shipment thereof unless otherwise specified.

If a Reflex Klystron/BWO Microwave Tube in Group C fails from causes covered by this warranty within the warranted hours of operation and maximum adjustment period, a pro rate adjustment, based on selling price, will be made at Varian's discretion, on one of the two (2) following bases:

$$\text{(1)}\quad \text{Adjustment} = (\text{Applicable Selling Price}) \times \frac{\text{Warranted Period} - \text{Months from Date of Shipment}}{\text{Warranted Period}}$$

$$\text{(2)}\quad \text{Adjustment} = (\text{Applicable Selling Price}) \times \frac{\text{Warranted Hours} - \text{Hours of Operation at Failure})}{\text{Warranted Hours}}$$

If a unit in Group D fails from causes covered by this warranty within the warranted period of operation, an adjustment based on selling price will be made as follows:

$$\text{(1)}\quad \text{Adjustment} = (\text{Applicable Selling Price}) \times \frac{\text{Warranted Period} - \text{Months from Date of Shipment}}{\text{Warranted Period}}$$

(2) Except the non-pro rata period shall be a 100% adjustment.

No adjustment will be made for failure beyond the warranted hours of operation or beyond the maximum adjustment period. In all cases failure shall be deemed to have occurred no more than seven days before the first date on which notice of failure is received by Varian.

Varian shall have no obligations under this warranty unless the applicable warranty period (number of hours of operation of the filament or heater, and/or number of months from date of shipment) is specified on Varian's quotation, or is otherwise agreed to in writing by Varian. In the event Customers and/or users of any Microwave Tube subject to warranty claim fail to keep accurate records of the number of hours of operation of the filament or heater, Varian, in its sole discretion, may reject any such claim or determine probable usage of the Product.

This warranty is expressly in lieu of and excludes all other warranties of any kind, express or implied, including warranties of merchantability and of fitness for intended purpose, use, or application, and all other obligations or liabilities on the part of Varian, unless such other warranties, obligations or liabilities are expressly agreed to in writing by Varian.

LIABILITIES

Varian's aggregate liability for damages shall not exceed the payment, if any, received by Varian for the unit of Product or service furnished or to be furnished, as the case may be, which is the subject of claim or dispute. In no event shall Varian be liable for incidental, consequential or special damages. Liability to third parties for bodily injury, including death, resulting from Varian's performance shall be determined in accordance with applicable law, and the total liability limitation stated above shall not be construed as a limitation on Varian for damages for any such bodily injury, including death. No action, regardless of form, arising out of, or in any way connected with, Products or services furnished by Varian, may be brought by Customer more than one (1) year after the cause of action has accrued. All patent liability of Varian shall be determined solely in accordance with the standard Terms and Conditions of Sale, Electron Device Group, Varian Associates, Inc.

Pub. No. 3187 10/81 Printed in U.S.A.

PALO ALTO MICROWAVE TUBE DIVISION • 611 HANSEN WAY • PALO ALTO, CALIFORNIA 94303

RETURN PROCEDURES

WARRANTY CLAIM

All claims under warranty must be made promptly after occurrence of circumstances giving rise to the claim and must be received within the applicable warranty period by Varian or its authorized representative. Varian reserves the right to reject any warranty claim not promptly reported. After expiration of the applicable warranty period, Microwave Tubes, Power Supplies and Components are not subject to adjustment.

Unnecessary expense and loss of time often can be avoided by calling the local Varian Field Office before returning a Product to the factory. Returned Products are frequently found to be within performance specifications required of new Products. The Varian representative may be able to determine the trouble and obtain satisfactory performance from the Product. This may save shipping time and expense and minimize equipment down time.

WARRANTY CLAIM FORM

Before any Product is returned for repair and/or adjustment, written authorization from Varian for the return and instructions as to how and where the Product should be shipped must be obtained. The Product type and serial numbers and a full description of the circumstances giving rise to the warranty claim should be included. Such information will help establish the cause of failure and expedite adjustment or repair. For this purpose, a **Warranty Claim Form** is shipped with each Product.

IMPORTANT

Any Product returned without a completed claim form will be considered to have met all contractual requirements. Both the Product and the completed claim form must be submitted to Varian Associates, Inc. prior to expiration of the applicable warranty period.

TRANSPORTATION AND PACKAGING

Any Product returned to Varian for examination must be sent prepaid via the means of transportation indicated as acceptable by Varian. Varian reserves the right to reject any warranty claim on any item that has been altered or has been shipped by nonacceptable means of transportation. Returned Products should be carefully packed in the original container, and unless otherwise indicated, shipped to:

VARIAN ASSOCIATES, INC.
Palo Alto Microwave Tube Division
Building 2, Receiving
611 Hansen Way
Palo Alto, California 94303

Attn: Returned Tubes and Products

AUTHORIZATION FOR EVALUATION

When any Product is returned for examination and inspection, or for any other reason, Customer and its shipping agency shall be responsible for all damage resulting from improper packing or handling, and for loss in transit, notwithstanding any defect or nonconformity in the Product. By returning a Product, the owner grants Varian Associates, Inc. permission to open and disassemble the Product as required for evaluation. In all cases Varian has sole responsibility for determining the cause and nature of failure, and Varian's determination with regard thereto shall be final.

If it is found that Varian's Product has been returned without cause and is still serviceable, the Customer will be notified and the Product returned at its expense; in addition, a charge for testing and examination may, in Varian's sole discretion, be made on Products so returned.

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WARRANTY CLAIM FORM
FOR
MICROWAVE TUBES, POWER SUPPLIES AND COMPONENTS

PROPER COMPLETION OF THIS FORM IS VITALLY IMPORTANT TO THE PROMPT AND EFFICIENT HANDLING OF PRODUCT WARRANTY CLAIMS.

I. This claim form, properly completed, must accompany any returned Product and be received by Varian's Palo Alto Microwave Tube Division prior to expiration of the adjustment period. Compliance with this requirement assures the user of the most prompt and thorough service possible. A Product returned within the adjustment period, but without the completed Warranty Claim Form, will be treated as out of warranty.

II. Complete the following information regarding the Product being returned:

A. Product Type: Varian Part No.__________ Serial No. __________

Customer Part No. ____________________

B. Customer Purchase Order No.____________________

Date of Purchase Order ____________________

C. Control Specification Number __________ Dated __________

(Check one) Document of VA ☐ your company ☐

D. Contract Warranty (either Varian Warranty code or specification paragraph)

____

Filament Hours __________ Warranty Adjustment Began__________

Adjustment Time __________ (months) Expires__________

III. Claim is made against warranty based on the following:

A. Specification(s) not met by the Product (list by specification and paragraph number):

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PLEASE FILL IN FOR FAILED PRODUCTS

(Place an "X" in the appropriate box to show what variance from normal was seen at the time of tube failure.)

* Product Serial No.	Date Installed	Date Failed	Filament Hours	Radiate Hours	Filament Current		Beam Current		Helix or Body Current		Hi Voltage Arcs		W/G Arcs		Coolant Flow		Mech. Problems		Elec Magnet Current	
Type No.					Lo	Hi	Lo	Hi	Nml	Hi	No	Yes	No	Yes	Nml	Lo	No	Yes	Nml	Lo

*It is necessary to have the Product serial number rather than the system serial number.

B. Describe the circumstances and/or sequence of events under which the Product failed. Include remarks relating to installation problems, system anomalies, etc.

IV. System used in ______________________________

Serial No. ______________________________

V. Purchaser's Name ______________________________

Address ______________________________

____

Claim made by: ______________________________

Person to contact for additional information:

Name ______________________________

Telephone ______________________________

____
(Signature)

____
(Date)

Return completed form promptly, with Product, to:

Varian Associates, Inc.
Palo Alto Microwave Tube Division
Building 2 Receiving
611 Hansen Way
Palo Alto, California

Telephone: (415) 493-4000
TWX: 910-373-1731

Attention: Returned Tubes and Products

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